UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF HANDS-ON ACTIVITIES ON STUDENTS' PERFORMANCES IN THE TEACHING OF SELECTED TOPICS IN BIOLOGY

ALBAN KANINGEN NUBAZUNG KPEMUONYE

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DECLARATION

Student's Declaration

I, **Alban Kaningen Nubazung Kpemuonye**, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature: ....

Date: ....

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba.

Prof. K. D. Taale

Signature: ....

Date: ....

DEDICATION

I dedicate this work to my late uncle, Mr. Emmanuel K. Kaningen, Patrick D. Kaningen, Isaac S. Kaningen, Edward M. Kaningen, my wife (Ms. Aminata Kperihinaah), my children (Ammon Y. Badia and Abran Y. Badia and Alexcia N. Badia), my mother, (Mrs Elizabeth T. Kaningen) as well as my late Dad (Mr. Kpemuonye Die-eebu Kaninigen).

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ABSTRACT

In the scope of this study, the focus was geared towards evaluating the impact hands-on activities have on the students' performances on selected topics in biology. An Action research was selected as the research design for the study with the inclusion of a quantitative and qualitative study as its research design. The study chose Queen of Peace Senior High School as its study area. A total of 45 students together with 9 teachers were adopted as the sample for the study using a convenient sampling method. With intense data collection procedure which use achievement tests and questionnaire for students and teachers respectively, the study outlined that hands-on activities have a significant impact on the academic performances of students. The study used t-test, mean and standard deviation as statistical tools to answer the research questions. This means that, the low performances of students in biology in some parts of the country can be significantly attributed to their lack of participation in hands-on activities. More so, the study achieved a positive attitude of students towards hands-on activities as compared to theory based class. Also, the study identified that through the introduction of Hands-on activities, the acquisition of process skills by students improved significantly as compared to when they were taught abstractly. More so, teachers outlined, inadequate funds, delay in the release of funds, non-existence of laboratory technicians and assistance as well as lack of knowledge to operate sophisticated laboratory equipment as the main challenges that obstruct the implementation of hands-on activities in the sampled school. This in contrast to other studies illustrate that, the case is the same across the country. In view of this, the study recommends that further research must be conducted on the impact of facilitators' knowledge on the conduct of hands-on work.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter comprises the background to the study, statement of the problem purpose, significance of the study, research questions, the delimitations and the limitations are also presented.

1.1 Background to the Study

Much of the scientific knowledge we want to teach in school science, which is consensually agreed and beyond reasonable dispute, might be read as implying a 'transmission' view of teaching and learning – whose aim is to 'transfer' the knowledge initially in the teacher's mind into those of the students. But this does not follow where the teaching of abstract ideas is involved. Transmission simply does not work. The learner must play an active role in 'taking on' the new knowledge. He or she has to 'make sense' of the experiences and discourse of the science class, and use it to 'construct meaning'. In this essentially constructivist view of learning, however, the knowledge that we want the students to construct is already known to the teacher throughout. The teaching laboratory is therefore very different from the research laboratory, as Millar (2004) points out.

The young child is often thought of as a little scientist exploring the world and discovering the principles of its operation. We often forget that while the scientist is working on the border of human knowledge and is finding out things that nobody yet knows, the student/learner is finding out precisely what everybody already knows. Learning science at the school level is not the discovery or construction of ideas that are new and unknown. Rather it is making what others already know your own.

A major goal of science education across the globe is fostering students' intellectual competencies such as independent learning, problem-solving, decision-making and critical thinking (Muijs & Reynolds, 2010). Perhaps, it is in recognition of this goal that the Ministry of Education, Ghana (MOE, 2010) stated in her national policy on education that there is the need for school programme to be relevant, practical and comprehensive. Also, the Ministry of Environment, Science, and Technology (MEST (2010) and Ministry of Environment, Science, Technology and Innovation (MESTI (2017) anchor their policy decision on We believe not only in pure research as a legitimate endeavour, but we also attach great importance to applied research. Modern science has taught us enough, and has already given us enough, to be able to tackle our agricultural, industrial and economic problems. It only the mastery and unremitting application of science and technology can guarantee human welfare and human happiness (Obeng, 1997). Consequently, several moves were made to improve the quality of science teaching at the secondary school level through the development of radical science curricula and teaching methodology (Abdullahi, 2002). These curricula, which Abdullahi (2002) described as activity-oriented, emphasise student-centred activities as the right approach to learning science. The objectives of these moves can only be achieved when the learners are actively involved in the classroom practices through activity-based, practical-oriented instructional method.

Biology as a science subject is a practical-oriented subject which focuses more on knowledge application than mere knowledge acquisition (Okeke, 2004). Biology plays a vital role in the economic development of the nation. According to Nwakonobi (2008), the recent advances recorded in the field of biochemistry, physiology, ecology, genetics and molecular biology are due to biological knowledge and applications. Biology plays a very important role in most human activities including finding solutions to the problems of food security, pollution, population explosion, climate change, disease outbreak, family health, poverty eradication, management and conservation of natural resources, various social vices as well as biotechnology and ethics. In addition, biology forms a link between secondary school level and many life-related fields of study offered at the tertiary level including biochemistry, biogenetics, physiology, ecology, zoology, botany, molecular biology, life sciences, engineering and biotechnology. Given its important role in the economic development of a nation, biology is a subject that must be properly taught and learnt by secondary school students in order to make it functional and relevant. Anything short of this will render the products of the products coming out from the system as half-baked and will find it difficult to respond to needs and problem of society.

Ministry of Education Biology curriculum/syllabus for senior high schools was designed to meet the needs of the society through relevance and functionality in its content, method, processes and application. The curriculum therefore has all it takes to make biology education functional and relevant to the society's needs and expectations for economic development.

Functional science education enables the recipient to explore school-industry linkage or school-world of works relationship by transferring the skills acquired from the school to the industry (Egbunonu & Okeke, 2005). Consequently, functional science education should be relevant to the students' environment and experiences as well as equip them with skills for consolidation of science behaviours. Egbunonu and Okeke

(2005) also stated that effective science teaching in schools should be laboratory oriented rather than text and lecture oriented. Therefore, functional biology education should develop in the students the right attitude, interest and skills to cope with life around them.

There is need to give the students a feeling of participation, confidence and interest in what they do with their hands so as not to perceive science as merely theoretical study. For this to be achieved, teaching of science must be practical-oriented. Cirfat (2013) maintained that whatever the argument for or against the impact of practical work on students' learning outcomes in Science, Technology, Engineering and Mathematics (STEM) subjects, it is incontrovertible that engagement of students in practical activities would make their learning more concrete and aid the development of many life-coping skills. These practical activities can only be properly handled through hands-on activities in science laboratories since according to Egbunonu and Okeke (2005) as cited Osuafor and Amaefuna. (2016), laboratory is regarded as the focal point for the study of science. A laboratory is any place or area where children learn to formulate problems, develop the ability to propose solutions, design and carry out experiments or investigations (Okeke, 2004). Biology laboratories are places where different types of experiments and researches concerning all the disciplines of life science take place for acquisition of skills. These skills cannot be acquired in the absence of well-equipped biology laboratories geared towards effective teaching and learning to empower students to become qualitatively and functionally educated.

Teaching methods have continued to occupy top position as factors affecting students' performances in secondary school science subjects, biology inclusive (Amaefuna, 2013). Through hands-on activities teaching method, students are given the opportunity of having first-hand experience in the observation and manipulation of science materials which will foster their intellectual competencies such as independent learning, problem-solving, decision-making and critical thinking as well as equip them with scientific skills to be self-reliant (Onyegegbu, 2006).

Over use of theoretical approaches to science teaching have been blamed for the poor outcome of education in science in Ghana (Anamuah-Mensah, 1989). According to Anamuah-Mensah (1989), earlier attempt at science practical work in Ghana was not audacious enough. Science Education Unit (SEU) 2010; 2011), science resource centre was introduced to Senior High School (SHS) in Ghana by the Ministry of Education in 1995 and later in 2013 where almost all science based schools had their laboratories equipped with materials and equipment. The main aim of the Science Resource Centre was to ensure that teachers do hands-on activities in the science lessons as stated in the biology syllabus. According to Taale, Hanson and Antwi (2011), the need to provide opportunities for teacher-trainees' practical skills acquisition resulted in the establishment of 107 Science Resource Centers (SRCs) throughout the country by the Government of Ghana. Additionally, about 200 science based senior high schools were also supplied with science equipment and materials in 2013 in similar efforts.

In teaching biology, it is recommended that the teaching periods be divided as follows: Theory - 3 periods per week (two 40-minutes periods) and Practical Work - 3 periods per week (three continuous periods of 40 minutes each) (MOE, 2010).

In Ghana, according to MOE (2010), elective biology syllabus, the teaching of biology should be student-centred and activity oriented. The teacher acts as a facilitator. For effective teaching and learning in this course, it is recommended that the school should establish a small botanical garden, animals in a cage, fishpond and insects in a cage. Plan must be made for visiting well-established experimental and commercial farms, agricultural research institutes and other institutions.

Dewey (1980) highlighted the proposals about activity-based learning and child-centered instruction and after that science curriculum studies has been emphasising and giving importance to science learning with hands-on activities (Hodson, 1990). Recently, educational researchers have been showing the factors affecting students' achievement and attitudes toward science and they have been conducting many studies to improve students' science achievement (Randler & Hulde, 2007; Taraban, Box, Myers, Pollard & Bowen, 2007; McCarthy, 2005; Hofstein & Lunetta, 2004; Bristow, 2000; Salend, 1998) and also attitudes (Ornstein, 2006; Osborne, 2003; Hofstein, Mooz & Rishpon, 1990) by using hands-on and inquiry based programmes. For example, the study of Randler and Hulde (2007) was related with the effect of hands-on programme on student's achievement about soil ecology. A total of 123 fifth and sixth grade students contributed in the study. Result indicated that students in the hands-on group demonstrated higher achievement than students in traditional textbook based programmes. Similarly, Taraban et al. (2007) in a studied with 408 students from six high schools to investigate the effect of a hands-on inquiry laboratory programmeme on students' biology achievement. The results revealed that use of hands-on inquiry laboratory gave an advantage to students to become more active learners, to enhance content knowledge and to develop science process skills.

Considering the fact that fundamental reforms in the new teaching strategies advocate and support the hands-on learning in science, the present study examined the effectiveness of hands-on activity enriched instruction on the sixth grade students' science achievement attitudes toward science. There have been many studies about hands-on learning focusing on different biology topics as earth and space science concepts, prokaryotic and eukaryotic cells, DNA structure and function, protein synthesis, and natural selection, biotechnology, cellulose enzyme, water, and genetic technology (Scharfenberg & Bogner, 2014; Randler & Hulde, 2007; Paris, Yambor & Packard, 1998).

Özlem and Eryilmaz (2011) on their study the "effectiveness of hands-on and minds-on activities on students' achievement and attitudes towards physics" in Turkey revealed that the analyses failed to show any significant differences between the means of the students' attitudes towards simple electric circuits. The results of this study are important especially for developing countries that cannot use expensive materials to make students physically active. The study further identified that, the teachers said they were used to teacher-centred learning environments and complained that preparing and guiding such activities takes too much time and effort.

Osuafor and Amaefuna. (2016) in their study of ''survey of biology teachers' use of activity-oriented, laboratory practical exercises to promote functional biology education' in Anambra State, Nigeria show that Biology teachers were willing to adopt practical-oriented strategies in teaching biology, conduct practical activities to a high extent, and perceive practical exercises as essential to effective teaching and learning of the subject. The provision of adequate number of laboratory materials, employment of adequate number of biology teachers, making provision for well-designed laboratory activities in the curriculum and training of teachers on how to effectively combine theory with practical are some of the strategies that will encourage biology teachers to conduct practical lessons (Osuafor & Amaefuna, 2016).

Etiubon and Udoh (2017) in a study to find out the Effects of Practical Activities and Manual on science students' academic performances on solubility in Uruan local education authority of Akwa Ibom state'' showed that students taught solubility with practical activities performed equally with their counterparts taught the same concept with practical manual. Results also showed that gender had no significant influence on the students' mean performances scores when taught solubility with practical activities and practical manual. Their recommendations among others were that science teachers should make effective use of practical activities and manual in teaching abstract concepts like solubility.

Leslie, Roger and Janet (2004) as cited in Taale, Hanson and Antwi (2011), attests to the fact that the engagement of the trainees in preparation of substances and tissues in living things as well as Classification and identification of living organisms provide the bases for the required skills that would enable trainees to teach science practical work at basic schools. The activities also provide opportunities for trainees to investigate thus what they see, what they are doing, and how they explain these things, Windschitl (2002). However, these activities were more of biology than physics and this did not give a balance practise of activities to trainees in the three subject areas.

Taale, Hanson and Antwi (2011) in his study of ''practical skills of science teacher-trainees in science and mathematics colleges of education in Ghana" revealed that practical activities were carried out once in a week in the colleges. This situation might not give enough room for trainees to have first-hand experience and also give them ample time to practice activities, since most activities in the colleges were already time-bound.

Again, in the same major finding, over 76% of the trainees further indicated that the activities in the design promotes better comprehension among them and also helped them to acquire new and better skill (Taale, Hanson & Antwi, 2011). He further intimated that though teacher trainees were engaged in varieties of practical activities, most of which were pencil-and-paper or minds-on activities rather than hands-on activities, trainees were able to acquire; observation, manipulative, and predictive skills. However, the skills tutors practiced with teacher-trainees were mostly to arouse and maintain trainees' interest in science but not necessarily guiding them to come out with their own findings.

Although relevant studies have recommended science instruction based on inquiry, rather than textbook implementation, by allowing the students to carry out scientific research on their own understanding (Gerstner & Bogner, 2010), student-centered experiments and hands-on activities are still rare in regular classroom instruction (Bohl, 2001). Similarly, in many developing countries, today's science instruction in the classroom depends on mostly reading or listening of scientific facts and taking notes and memorizing.

While there is some substantial amount of literature on effect of hands-on activities in physics and chemistry, there is however little or no literature uncovered by the researcher in his search on the effect of hands-on activities on students' performances in biology in Ghana. Particularly there is too little research that has been conducted on the effect of hands-on activities on students' performances in selected topics in biology. There is therefore a need for research to focus on the effect of hands-on activities on students' performances in biology. This study therefore aims at investigating the effects of hands-on activities on students' performances in selected topics in biology.

1.2 Statement of the Problem

The biological science curriculum/syllabus for senior high schools, places emphasis on the importance and impact of practical work on the understanding of theories. For close to a decade now (2011 to date), WAEC Chief Examiner's report on Biology has consistently indicated that students poorly handle practical questions from the theoretical point of view which does not fetch them the full mark (WAEC, 2020). The main purpose of the Chief Examiners' report is to inform teachers about the strengths and weaknesses of candidates and also suggest solutions for teachers to emphasise in the course of their teaching. Recurrence of the weaknesses of students with regard to their unpracticality can be keenly associated with the insufficient exposure of students to hands-on activities. The report further suggests that, for students to score better teachers much do more of hands-on/practical activities on theories for students to grasp the concept quick and easy.

Several studies including (Daba, Anbassa, Oda and Degefa, 2016); Silay (2010); Abdisa and Tesfaye (2012)) have examined the effect of various strategies on the performance of students in biology. Silay (2010) used an experimental approach to measure the effect of practical activities on students' achievements and attitudinal change. Even though there was appositive effect to these two factors, the setting of this study is not applicable to that of this study. Same can be said about Daba, Anbassa, Oda and Degefa, (2016) which was conducted in Ethiopia and Abdisa and Tesfaye (2012) which was conducted in Nigeria. According to the studies examined, instructional interventions are likely to alter students' achievement as well as their attitude about the subject. However, there are no comparative research on two study groups to examine the effects of hands-on activiesit on students' performances in Ghana, particularly in the Northern sector of Ghana. The current study was designed to fill this gap.

1.3 Purpose of the Study

The purpose of this study, is to determine the effect of hands-on activities on students' performances in the teaching of selected topics in biology. The research is also greatly motivated by the limited literature in the area of hands-on activities in and its effect on students' performances in biology in Ghana.

1.4 Objectives of the Study

Five objectives will guided the study. The study seeks to:

1. Determine the effect of hands-on activities on students' performances in selected topics in biology in Queen of Peace Senior High School.
2. Determine the effect of hands-on activities on students' attitude towards selected topics in biology in Queen of Peace Senior High School.
3. Determine the effect of hands-on activities on students' acquisition of process skills in Queen of Peace Senior High School.
4. Determine the challenges biology teachers face in organising hands-on activities.

1.5 Research Questions

The study addressed the following research questions:

1. What is the effect of hands-on activities on students' performances in selected topics in biology?
2. What is the effect of hands-on activities on students' attitude towards selected topics in biology?

3. What is the effect of hands-on activities on students' acquisition of process skills?
4. What are the challenges biology teachers face in organising hands-on activities?

1.6 Research Hypotheses

This research will address the following hypotheses:

Hypothesis

H_0: There is no significant relationship between hands-on activity and students' performances in biology.

1.7 Significance of the Study

The results of this study provide some valuable feedback to science teachers and science educators in Ghana's educational system for several reasons. Although relevant studies have recommended science instruction based on inquiry, rather than textbook implementation, by allowing the students to carry out scientific research on their own understanding (Gerstner & Bogner, 2010), student-centred experiments and hands-on activities are still rare in regular classroom instruction (Bohl, 2001).

Secondly, science teachers and researchers can get benefits about how to implement hands-on activities enriched instruction in biology, and how hands-on activities affect students' performances in biology.

Finally, this study can assist curriculum developers when they want to evaluate and review science programmes to ensure the practical teaching of science.

1.8 Limitation of the Study

A broad survey of the study would have clarified to a large extent the real effect of hands-on activities on students' performances in selected topic in biology. However, time and cost constraints prevented the study from extending to other institutions. Therefore, the results of the study would be strictly applicable to the elective science and Home Economics students doing biology in Queen of Peace Senior High School in the Nadowli/Kaleo District in the Upper West Region. Not every respondent who receives questionnaires are likely to answer and return it. The current tracking system in the SHSs may also after meeting the designated classes.

1.9 Delimitation of the Study

The study was delimited to only First year students of elective science and Home Economics students offering biology in Queen of Peace Senior High School. This is because most of these students have not been exposed to much hands-on activities (if any) in Science or biology concepts at the junior high school level. This school has received science resource centre package in 2013 and therefore have appropriate instructional materials which can be obtain by the researcher.

1.10 Organisation of the Study

The study is structured into five main chapters. Chapter One captures the background of the study, the problem statement, objectives, research questions and the significant of the study. Chapter Two examines the review of literature. Chapter Three looks at how the research is going to be conducted by looking at the research methodology. Chapter Four deals with the analysis and discussion of the data. Chapter Five which is the final chapter looks at summary of the findings, conclusions, recommendations and areas for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

In this chapter, a review of related literature to this study is presented: It includes the works of recognised authorities and previous research works. The chapter highlighted the following: Theoretical and Conceptual Frameworks which provides the concept within which this study was undertaken. It included the History of Science Education in Ghana as well as the aim of teaching and learning biology. It also discusses the Attitudes of Biology Students towards Science Practical Work, the Perception of SHS Biology Teachers towards Biology Practical Work, Practical Method in the Teaching and Learning of Biology, Practices involved in the Teaching and Learning of Biology and problems affecting the teaching and learning of biology. Finally, the gaps in research were addressed in the scope of this study.

2.1 Theoretical Framework

This study is based on the theory of constructivism. Constructivists view learning as an active process whereby learners learn to discover principles, concepts and facts for themselves. The instructor and the learners are equally involved in learning from each other (Hoy, 2019). Social constructivists, such as Vygotsky, emphasise the importance of the learner being actively involved in the learning process so that he/she can construct his/her own understanding. It is believed that learners with different skills and backgrounds need to collaborate on tasks, such as when they are doing practical work together in order to arrive at a shared understanding of the truth in a specific field. The term "constructionist teaching" is commonly used in the teaching and learning environments (Ritchie & Rigano, 1996). The teacher according to the constructivist theory is not seen as a person who is responsible for constructing knowledge for the learners but rather is denoted by the many responsibilities given to him\her during instruction in mediating meaning at the inter-mental plane in the classrooms. Thus, the teacher's role becomes that of a guide provocateur, facilitator, creator of opportunity and co-developer of understanding with learners. The instructional practices of the Biology teachers should therefore assist learners to acquire the process skills (Ritchie & Rigano, 1996).

Since the sixteenth century, when experimental science was supported, it has been widely understood that practical or empirical work is the primary responsibility of scientists. As a result, there is a common view that students should learn science by doing what scientists do in order to educate our future leaders in science (Klainin-Yobas, 1996). Most Science educators believe that if a child participates in hands-on activities and is actively involved in the learning process, science learning will be more effective. Practical work has been an important aspect of school Science teaching since the late nineteenth century, when Science was made a compulsory subject in a number of countries (Klainin-Yobas, 1996).

2.2 History of Science Education

The realm and limit of science, its level of uncertainty, its biases, its social components, and the rationale for its trustworthiness are all examples of rarely taught but highly significant features of doing science (Kilbourne, Abraham, Goodrich, Bowersox, Almirall and Nord, 2013). Throughout history, education has served a variety of purposes, ranging from spreading the Gospel to forming an elite group to administer the colony. In 1828, the Basel Mission Society of Switzerland was instrumental in creating an educational network in Ghana. Workshops on reading, writing, and arithmetic were also held for students to learn practical skills. Practical science has being gradually added since 1961. The Ministry of Education went on to conduct scientific in-service training courses for middle school teachers. Between 1962 and 1965, science specialists from the Ministry of Education and middle school science teachers collaborated to create a four-year science programme. During the same time period, five scientific centres' were built, one in each regional capital, each with apparatus and resources for teaching science to middle school students who came from nearby schools (Crook and Haggis, 1969).

An Education Review Committee advised in 1966 that some subjects, such as English, Science, and Mathematics, be made mandatory for all secondary school students and studied throughout their education. The group also proposed that science be included among elementary school topics, with science being considered in light of Ghana's increasing scientific, technological, and cultural demands. Similarly, it backed the addition of science as a required subject in teacher education colleges to prepare future primary school teachers to teach science.

A comparative survey made in 1963 as indicated in Crook and Haggis (1969) showed that over 30% of the secondary schools in the country were satisfactorily equipped or had only minor difficulties with apparatus, and only one school in the sample had no apparatus at all. There was rapid increase in enrolment of students following science courses in the Sixth Forms as indicated in the Advance Level Examination results between 1963 and 1967. Most of the preliminary work for the Physics, Chemistry and Biology syllabus was carried out by the Ghana Association of Science Teachers which had also organised in-service training courses for Sixth Form teachers of science. The separate subject Botany and Zoology was replaced with Biology. A national science museum, which was established in Accra in 1965, organised out of school science activities which were well attended by school children and others in the Accra area. The activities included regular showings of scientific films, exhibitions and science fairs.

In 1995, the Ghana Government set up Science Resource Centres at all the then 110 districts to supplement teaching and learning of science at the secondary level. The centre schools had satellite schools that visited at regular intervals for science lessons. Science resource buses were provided to the centre schools to convey satellite students to the centres and for field trips. Also, the Resource centres were used to train centre and satellite school teachers as well as Junior Secondary School teachers. Furthermore, the centres also served occasionally as workshop centres for Ghana Association of Science Teachers annual district/municipal Science Technology and Mathematics Education clinics, science workshops organized by Ghana Education Service (GES) etc.

A study conducted by Gyemera (2006) on some beneficiary schools after the SRCs had operated for about ten (10) years revealed a lot of positive developments, for example, students could carry out some practical activities in the SRCs-resulting from the establishment of the SRCs. The study also identified some challenges. These challenges included virtual collapse of most of the (SRCs). For example, Gyamera reported that 470 out of the 660 computers supplied to the SRCs in 1996 had broken down. The rest had serious defects that hinder their effective utilization. Additionally, the spare parts of these computers were not available in the ICT market. He also noted that some of the teachers who were trained to manage the SRCs were either transferred to other schools without SRC or had gone retirement. The inability to purchase consumables used at the SRCs, the erratic payment of user fees by most satellite schools and host schools and the inadequate motivation of centre staff interacted to exert a negative impact on the operations of the SRCs. These in turn negatively affected the quality of practical activities organized at the centres. If science resources are to continue to serve the purpose for which they are established then adequate material, financial and human resources should be supplied to make the centres fully functional.

In 2009, new equipment and materials were supplied to the existing centres to replace the old ones. After the supplies were made, training was given to teachers in the satellite schools and the some of the old materials and equipment distributed to the satellite schools (Miller, 2016). After 2009, the yearly maintenance allowances/imprest of one thousand Ghana cedis was stopped. Miller also identified the following as some of the challenges that hindered the operation of the old SRCs;

1. Refusal to pay commitment of user fees by the heads of satellite schools to the resource centre schools.
2. Increasing cost of maintenance of SRC vehicles.
3. Teachers trained to manage the SRCs were fully engaged in teaching in the schools. These teachers also considered students from the satellite schools as an extra work with no motivation. So lessons were then left in the hands of teachers from the satellite schools who also had no or little knowledge in the use of the equipment and materials in the centres.
4. Refusal by centre teachers to practice also affected the operations/running of the SRCs.
5. Teachers who had the earlier training moved to other schools without SRC while others also left for other jobs.

6. According to Miller (2016), as long as the biology syllabus remains as bulky as it is, such facilities/interventions will never yield the intended results as most teachers will concentrate on finishing the syllabus.

With SRC project III, many of the senior high schools offering science programmes received materials and equipment since the SRC project III stopped those schools' visit to the science resource centre. Teachers in these beneficiary schools were also trained and traveling cost to centre schools by satellite schools among others have been minimised or stopped.

2.3 Meaning of Practical Work in School Science

There is confusion in the broader science education community about the definition of "practical work". This confusion makes discussions about the value of "practical work" difficult. A variety of terms exist to describe practical work, many of which are frequently used with little clarification. For example, Science in the National Curriculum uses several terms with little attempt to explain their meaning: 'Practical and enquiry skills', 'practical and investigative activities', 'independent enquiry' and 'experimental work' (Qualifications and Curriculum Authority (QCA), 2007a/b). Science Community Representing Education (SCORE) (2008) also defined practical work as any science teaching and learning activity which involves students, working individually or in small groups, manipulating and/or observing real objects and materials, as opposed to the virtual world.

Also, Science Community Representing Education (SCORE), (2009a) produced a framework for practical science in schools defining practical work in science as 'a "hands-on" learning experience which prompts thinking about the world in which we live'. An associated report of SCORE (2009b), considered two main categories of activities that are considered as practical work. These categories are: Core activities which include investigations, laboratory procedures and fieldwork. These hands-on activities support the development of practical skills and help to shape students understanding of scientific concepts and phenomena. Direct related activities which include teacher demonstrations, experiencing phenomena, designing and planning investigation, analyzing results and data analysis using ICT. These activities are either a key component of an investigation or provided valuable first-hand experiences for students. In addition, some argue that other activities such as use of computer simulations, modellings, use of surveys, presentations, group discussion and role play can also constitute what is meant by the term practical activity (SCORE,2008). However, others disagree and believe these activities would not come under the practical activity 'umbrella' and rather they should be used complementarily alongside other practical activities, rather than be a substitute for them (Woodley, 2009), Wellington (1989) also noted that there were 'at least six types of activities' that took place in school science 'that could probably be classified as practical work' (p. 12):

1. teacher demonstrations; class practical with all learners on similar tasks,
2. working in small groups
3. a circus of 'experiments' with small groups engaged in different activities,
4. rotating in a carousel
5. investigations
6. problem-solving activities.

According to Gott and Duggan (1995), these different types of activity have different purposes but as Wellington also pointed out, many 'experiments' were nothing of the sort because no new knowledge was being created. Nzewi (2008), asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching) more real to the learners as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters. Laboratory experiments (activities) are characteristics features of science teaching at all levels of education (Adane &Adams, 2011) Abel and Lederman (2007), authors of the Handbook on Research on Science Education, also provided what they called classical definition of school science laboratory activities (practical activities) as learning experiences in which students interact with materials or with secondary sources of data to observe and understand the natural world. For example, aerial photographs to examine lunar and earth geographic features; spectra to examine the nature of stars and atmospheres; sonar images to examine living system. (Lunetta, Hofstein & Clough, 2005).

The views of current practitioners and other stakeholders on their definition of practical work were also explored through questionnaires submitted during stakeholder workshops. The questionnaires endeavored to identify what teachers considered to be practical work in terms of specific activities rather than overarching statements. Both the primary and secondary survey respondents were offered a list of 13 different types of activity. Two of these: investigations and fieldwork were almost unanimously accepted as being seen as practical work. Also receiving majority support for inclusion were: laboratory procedures and techniques, collecting and analyzing data using IT, designing and planning an investigation- though there are significant differences between primary and secondary responses. Those offering individual views mentioned similar activity categories in answer to the question: what do you consider practical work to be? The individual responses ranged from the inclusive: doing things with stuff (as quoted by a 11year-old boy), anything not theory to be specific: building instruments (meteorologist) and showing the distinctive nature of the different sciences and giving career orientation (pharmacologist).

Other individual correspondent also concentrated on processes rather than activities and the questionnaire respondents agreed with this approach. Around half approved of designing and planning, data collection (including using ICT), analyzing and evaluating. In a report written for the US National Academy of Sciences, Robin Millar pointed out that when using the term ‘practical work’ he referred to ‘any teaching and learning activity which at some point involved the students in observing or manipulating the objects and materials they were studying’ (Millar, 2004). By way of explanation, Millar (2004) added: “I use the term ‘practical work’ in preference to ‘laboratory work’ because location is not a critical feature in characterizing this kind of activity. The observation or manipulation of objects might take place in a school laboratory, but could also occur in an out-of-school setting, such as the student’s home or in the field (e.g. when studying aspects of biology or Earth science). I also prefer not to use the term ‘experiment’ (or ‘experimental work’) as a general label, as this is often used to mean the testing of a prior hypothesis. Whilst some practical work is of this form, other examples are not”. (Millar, 2004).

In conclusion, most stakeholders would accept a definition of practical work in science which includes investigation/enquiry and laboratory/field work procedures and techniques. There is some concern that too wide a definition may reduce students’ opportunities to engage with the physical world, but general agreement on the importance of activities which link these to the concepts, theories and context of science. A potentially significant differences is between primary and secondary teachers with respect to the role of teacher demonstration. In reviewing literature on the aims and purposes of practical work and why it is important in science education, the comment made by Solomon (1980) can generally capsules most teachers' first thoughts.

Practical work is an important part of science but as to what value is practical work as part of science education still remains unfound. Since then, there have been many educational researchers who have produced categories of reasons for conducting practical work within science education. Shulman and Tamir (1973), and Anderson (1976), both proposed aims of practical work. Whilst both were unique in their own right, there were common themes, such as appeal to students, improvement of scientific skills and promotion of scientific culture. Shulman and Tamir (1973) suggested five major aims of practical work in science education as follows: (1) To arouse and maintain interest, attitude, satisfaction, open mindedness and curiosity in science; (2) To develop creative thinking and problem solving ability; (3) To promote aspects of scientific thinking and the scientific method (e.g., formulating hypotheses and making assumptions); (4) To develop conceptual understanding and intellectual ability; and (5) To develop practical abilities (e.g. designing and executing investigations, observations, recording data, and analyzing and interpreting results).

Anderson, (1976) also proposed some aims of science practical work as: (1) To foster knowledge of the human enterprise of science so as to enhance student intellectual and aesthetic understanding (2) To foster science inquiry skills that can transfer to other spheres of problem- solving; (3) To help the student appreciate and emulate the role of the scientist; (4) To help in understanding the tentative nature of scientific theories and models. Hofstein and Lunetta (1982), suggested that the purposes, as stated above, were rather similar to the purposes for science as a whole that distinct reasons for practical work were needed, especially at a time when there had been a shift from student-led work. This provided less time and experience in the science laboratory, primarily due to the need to meet examination requirements (Gott & Duggan, 1995). Hofstein and Lunetta (1982) found that when suitable activities were used in laboratories effective development and promotion of logic, inquiry and skills for problem-solving might occur. Although to what extent such kills and inquiry could be learnt just as effectively through other pedagogic methods and indeed in other subjects has been raised (Clackson &Wright, 1992).

According to Osborne (1998), unpicking the Gordian knot that ties science education to its practical base requires, first and foremost, a reconceptualization of the aims and purposes of science education. (Osborne, 1998). Wellington (1998) commented that 'teachers are always surprised and even shocked, when asked to consider what practical work in science is for. This phenomenon might simply reflect the almost sacrosanct position of 'the practical' in school science (p.143-155). Less anecdotal evidence of teachers' attitudes towards practical work comes from sources such as the ICM survey carried out on behalf of NESTA (the National Endowment for Science, Technology and the Art). ICM reported that 84% of the participants considered practical work to be 'very' important with 14% considering it 'quite' important. The high level of importance attached to practical work begs the question, why is practical work so important? The answer to that question emerges from an examination of the research into teachers' views of the aims of practical work.

In an attempt to make sense of the various aims, Wellington (1998, pp.145-146) offers a 'crude summary of arguments' for the use of practical work. 'Cognitive argument argued that practical work can improve students' understanding of science and promote their conceptual development by allowing them to 'visualize' the laws and theories of science. It can illustrate, verify or affirm 'theory work'. Affective arguments to practical work, also argued that is motivating and exciting – it generates interest and enthusiasm. It helps learners to remember things; it helps to 'make it stick'. Skills argument also argued that practical work develops not only manipulative or manual dexterity skills, but also promotes higher-level transferable skills such as observation, measurement, prediction and inference. These transferable skills are said not only to be valuable to future scientists but also to possess general utility and vocational value. However, Wellington notes several counter arguments to all these claims for practical work. Firstly, doing science and understanding science theories are different (Leach & Scott, 1995). Secondly, there is evidence that many students, particularly girls, are not very positive about doing experiments (Murphy & Beggs, 2003; Qualter, Strange & Swatton, 1990). Thirdly, evidence for the transferability of skills is limited (Ausubel, 1964; Lave, 1988).

Wellington (1994), also noted that the arguments for the value of practical work in promoting group work have also been criticized. It would appear that there might be some scope for the science education community to engage in consideration of the purpose of science education and, in particular, the aims and purpose of 'practical work'. Students have a lot to benefit from practical which may include increasing students' interest and abilities in science subjects as well as their achievement in science (Pavesic, 2008). In addition, Tobin (1998), stated that, meaningful learning is possible from a given laboratory experiments if the students are given ample opportunities to operate equipment and materials that help them to construct their knowledge of phenomena and related scientific concepts. There are reports that emphasize teaching a science with the help of laboratory experiments to be more enjoyable and stimulating to students than teaching the same subject matter only through lecture (Hofstein &Lunetta, 2004; Teibo, 2001).

Over the years, there have been several studies that have reported teachers' views of the aims of practical work. Kerr (1963, p. 288-350) identified 10 aims reported by teachers and a further 10 more were reported by Woolnough (1996, p.23-30). Swain, Monk and Johnson (2000, p. 131-132,) in a study found another 10 aims. However, the four most popular aims in all three studies were: to encourage accurate observation and description; to make phenomena more real; to arouse and maintain interest; to promote a logical and reasoning method of thought. By comparing the three studies, some trends appear, which might be explained by the influence of the National Curriculum. Four aims were rated more highly in the Swain, Monk & Johnson (2000) study than they were in the Woolnough (1996), study. These aims were:

1. to practice seeing problems and seeking ways to solve them;
2. to develop a critical attitude
3. to develop an ability to cooperate;
4. for finding facts and arriving at new principles.

Millar (2004), argued that It is also important to distinguish, and keep in mind that, the school science curriculum in most countries has two distinct purposes. First, it aims to provide every young person with sufficient understanding of science to participate confidently and effectively in the modern world a 'scientific literacy' aim. Second, advanced societies require a steady supply of new recruits to jobs requiring more detailed scientific knowledge and expertise; school science provides the foundations for more advanced study leading to such jobs. These two purposes may lead to different criteria for selection of curriculum content, to different emphases, and (in the particular context of this paper) to different rationales for the use of practical work. In reviewing literature surrounding the nature and purpose of practical work, what is reflected is how there is no research specifically, into what, and why, students think and feel about practical work as well as whether practical work has an affective value in influencing students' decision to continue with science post compulsion. It appears that practical work is seen as motivating by teachers as shown through the vast amount of empirical data (Holstermann, Grube, & Bögeholz 2009). However, there is a need to ask students direct questions regarding their affection to practical work, such as "do they enjoy practical work? Does it motivate them?" (Wellington, 2005,p. 101) and probe further as to what is it that they are indeed motivated to do and why this is so. As Bennett and Hogarth (2009) pointed out, the plurality of espoused aims for practical work in science make the task of assessment very difficult. As is currently practiced, students claim to find practical work an 'enjoyable and effective way of learning science' (Hodson, 1992, p. 115) and this has been reported in many previous studies (Osborne & Collins, 2001; Jenkins & Pell, 2006). Many studies (Kerr, 1963; Woolnough, 1996; Hodson, 1990; Swain, Monk & Johnson, 2000,) have examined the aims of practical work in science education.

One common theme that emerges from these studies is the need 'to arouse and maintain' positive attitudes in students' in order to improve the likelihood of their continuing to study science post compulsion. According to Anamuah-Mensah (1989), The major aim of science practical work in secondary schools in Ghana is to bring about the technological development needed by the nation through the production of young scientists who would be able to produce and handle simple technological devices to make day-to-day life activities and to make life easier and more comfortable. Thus, practical work in secondary schools should develop essential scientific skills in the learners infusing into them creative mind to enhance their technological applications. The justification for practical work in science at the senior high school level is supported by the aims of practical science in the West African Examination Council Syllabus as follows:

1. To acquire adequate laboratory and field skills in order to carry out and evaluate experiments and projects in physics, chemistry and biology
2. To acquire necessary scientific skills, for example, observations, measuring, manipulating, classification and interpretation of scientific data
3. To be able to interpret and illustrate knowledge of physical, chemical and biological principles and to develop the ability to perform simple experiments and makes inferences from the results established.
4. To acquire scientific attitude for problem solving
5. To be able to apply scientific principles in everyday matters in order to solve personal, social, environmental, community, health and economic problems.

The importance of practical work in science is widely accepted and it is acknowledged that good quality practical work promotes the engagement and interest of students as well as developing a range of skills, science knowledge and conceptual understanding The main purpose of practical work in science education is to provide students with conceptual and theoretical knowledge to assist them learn specific concepts and scientific methods to understand the nature of science. Thus practical work stimulates learners interest in the science subject they are studying when they are made to personally engage in useful activities; knowledge obtained through practical work and experience, promote long term memory that theory alone cannot do. From this reason, it becomes obvious that a learner acquired more in any science lesson if giving the opportunity to do activities, ranging from manipulating apparatus, classifying, designing, experimenting, hypothesizing to make inferences and verifying results. In addition, practical activities in biology provide opportunities for students to actually master science and become exposed to learning about science (Nwagbo & Chukelu, 2011). Woolnough and Allsop (1985), claimed there were three essential aims that are the principals of scientific activity, and justification for the use of practical work. These were:

1. developing practical scientific skills and techniques;
2. being a problem-solving scientist;
3. getting a feel for phenomena.

Surprisingly, the aims they proposed did not include the motivational, stimulating and enjoyable aspects that practical work has since been claimed to promote or produce them. However, there had been comments made before this time about the use of practical work to encourage and motivate students according to teacher opinion, such as in Kerr (1963), Selmes, Ashton, Meredith and Newell, (1969), Kelly and Monger (1974). According to Woolnough and Allsop (1985 p.195-198), it seemed that the motivation al aspect of practical work for students was far too restrictive and generally only favoured because the alternatives were presented in a negative way by teachers to students. According to Swain, Monk and Johnson (2000), this approach of using practical work as a means of behavior control has been used by teachers in the United Kingdom as a strategy for dealing with mixed achieving classes. Due to this strategy, Swain, Monk & Johnson (2000, p 281-292), suggested three further aims as reasons for teachers doing practical work. The aims included,

1. to reward students for good behavior;
2. to allow students to work at their own pace;

3. to add variety to classroom activities

Even though students may hold an interest and want to conduct practical work, it does not necessarily imply cognitive learning purely because the context of that learning has become seemingly more relevant to the student (Adey,1997). Indeed, just because students find doing practical work ‘enjoyable’ does not mean that students will be thinking or learning about what they are doing, rather the opportunity to have the freedom of something different in learning science. In such a case, a possible purpose to enhance scientific knowledge via practical work seems difficult to attain. This is especially true when doing science is ineffective enhancing students understanding or learning of science (Driver, Squires, Rushworth & Wood-Robinson,1994 p.110-112). Hodson (1990, p.40) suggested five possible aims of the purpose and justification of practical work based on teachers’ responses. These are:

1. To motivate, by stimulating interest and enjoyment.
2. To teach laboratory skills.
3. To enhance the learning of scientific knowledge.
4. To give insight into scientific method, and develop expertise in using it.
5. To develop certain ‘scientific attitudes’, such as open-mindedness, objectivity and willingness to suspend judgment.

However, after critical analysis of the above aims, Hodson (1990), found that “theoretical arguments and research evidence have reinforced the view that practical work in school science as presently organized is largely unproductive and patently unable to justify the often extravagant claims made for it”(p.39). Indeed, Clackson and Wright (1992) drew a similar conclusion, although they suggested there might be an argument for having practical work 30 as a subject in its own right. The reasoning behind this was that the acquisition of skills was rather generic and thus not primarily concentrated within science education. The problem that many educational researchers had found was that due to the undefined nature of what and how best practical work should be conducted in schools, many difficulties arose with pedagogy and learning (Clackson & Wright, 1992; Hodson, 1990). According to SCORE (2008), the problem with understanding the true purpose of practical work within science education is still an issue. This unclear focus may lead to an array of different approaches of practical work in schools that potentially will influence the learning outcomes for the students (Reiss, Millar and Osborne 1999).

2.4 The Nature of Biology Practical Work

Review of literature on the nature of practical work looked at the totality and the whole embodiment of biology practical work. This include the teaching and learning environment for practical work, methods used in teaching practical work, time for teaching biology practical work and the teaching and learning resources available for teaching and learning biology practical. There have often been agreements about the place of practical work in the learning of science education but there seems little agreement of the nature of this practical work conducted in secondary schools. Indeed, the statement made nearly thirty years ago by Solomon (1980, p.13) seemed "science teaching must take place in a laboratory; about that at least there is no controversy". Science simply belongs there as naturally as cooking belongs in a kitchen and gardening in a garden". This may encapsulate an argument for the majority of science teachers' attitudes for why they think they do practical work. However, it still begs the question of how best this practical work could be conducted. One important aspect in the study of the sciences and biology as such is the method used during impartation of knowledge to the students.

Teaching biology through investigation, research activities, project approach and problem solving and by linking these with a focus on local environment achieves better understanding of biology as opposed to rote learning of scientific facts and theories for examinations after which learning ends. Too often in practical examinations, students show that they cannot use even rulers accurately for measurements. They claim that teaching of science in Ghana has become more theoretical than practical. There is therefore the need to search for more effective strategies that are likely to improve achievement in senior high school biology practical work. Such strategies perhaps, include cooperative based learning instructional strategies (activity-based) which have been found to improve biology learning outcomes (Okebukonla, 1984; Iroegbu, 1998; Slavin, 1990) and project base learning. Peer tutoring is a personalized system of instruction which is leaner rather than teacher oriented, it emphasizes active student participation in the learning process. It is an individualized attention to a learner by a person of similar status who serves as the tutor.

Studies have shown that this instructional strategy benefits both the students being tutored and the tutor, although the tutor is associated with greater cognitive gains than the student being taught (Annis, 1982, Bargh & Schul ,1980; Lambiotte et el; 1987). It has also been observed that when biology lessons are done in groups students are allowed to make valuable decisions which result in satisfactory accomplishment. Mary (1996) explained that group work during practical is a pervasive and influential feature of the classroom ecosystem which must be encouraged in the teaching and learning of biology in the senior high schools. Activity -based methods of teaching, in the form of group work during practical, enable students to be actively involved in seeking information that can be applied to solve real life problems. By these method students are placed at the center rather than the teacher and it's not text book centered. The activity method is used to teach science in which the child is placed at the center of the learning process and made to interact with materials and experience things for themselves. Practical work is an inquiry and hands on activity which makes it possible to transfer knowledge on higher order cognitive levels and create curiosity in students. Practical work develops problem-solving skills and a deeper understanding of the concepts and principles in biology for students. When students do biology hands on, they will understand it and will enjoy the learning process since it will be relating what they will have learnt to real life situations.

The challenges of the modern world require individuals who can apply their theoretical knowledge to solve practical real life problems such as environmental and economic challenges. Hence, practical work prepares students for adult life since it fosters the theory they would have learned. Students, through doing practical work, would be doing what real scientists do and they would appreciate that theories are generated from research. Doing practical work forms the basis for good research skills in students. The project approach, therefore, enhances the development of many practical work skills. Katz and Chard, (1989 p.5-7), correctly stated that "The Project Approach, involves children selecting a topic of interest, researching and studying it, and solving problems and dilemmas as they arise." The Buck Institute of Education describes it as, "Project Based Learning (PBL), where students go through an extended process of inquiry in response to a complex question, problem, or challenge". The extended interactions with learning materials enable students to learn new material and transfer understanding to other new situations. The importance of time spent with learning material is emphasized further by Bigala (1996, p.74), who defines project work "as a scheme of work in which the students work singly or in groups, over a period of time varying from a few days to several weeks". Khan and Zafar (2011), carried out an experiment in which they sought to compare the effectiveness of the traditional laboratory and the inquiry (project) methods in developing scientific process skills in grade nine students using selected topics in the biology syllabus. They determined that, using a science process skill scale device, students taught using the inquiry method developed better science process skills than those taught the traditional way. In addition, Shoemaker (1989), explains how science is best taught in a holistic way which reflects the instructiveness of the real world. This complements Benson (2004), argues that the implication is, therefore, that teaching strategies should be based on the premise that learning is a series of connections and goes on to suggest that the project method and theme teaching fit this description.

Abimbola (1994), makes the case that in Nigeria; teachers usually give the excuse of lack of materials and equipment for not carrying out practical work even when an activity can be done without conventional equipment. Abimbola's article cites that while there are essential laboratory skills like manipulation of various forms of equipment, equally important inquiry skills can be developed through methods like projects done outside the laboratory. Bigala (1996), found it feasible to use the project approach in schools in Malawi and goes on to give examples of such projects in different subjects including biology. Bigala (1996), also suggested ways of structuring the projects, organizing, and timetabling them. The activity-based method of teaching considers students as very important in the instructional process, where teachers build on the students' experiences. Also, the procedure used for the activity-based method of teaching is based on current information and research in developmental psychology involving cognitive, affective, experimental and maturational issues. Co-operative work on problems and issues is a common phenomenon associated with the activity-based methods of teaching science. Also, individualized and personalized instructional strategies, recognizing student's diversity are employed. The curriculum structure for the activity -based method of instruction is multifaceted, including local and community relevance as well as considering values ethical and moral dimension of problems and issues, using the natural environment and community resources. Some of the approaches used for the activities include group activity, project work, practical work, inquiry, discovery, discussion and demonstration.

In all the approaches mentioned, practical work is found to permeate in all aspects and they in turn relate to one another. In science practical work, it is necessary for students to offer each other assistance. According to Lazarowitz, Lazarowitz-Heads, and Bird, (1994), learning methods generally involve heterogeneous groups working together on tasks that are deliberately structured to provide specific assignments and individual contributions for each group members. Practical work is found to enhance the teaching and learning of science and for that matter biology at all levels. Co–operative learning within groups will enable students to have cognitive as well as social benefits as they clarify their own understanding and share their insights and ideas with each other as they interact within the group during biology practical activities (Lazarowitz, Lazarowitz-Heads & Bird 1994). They further found that emphasizing laboratory inquiry had a small equity effect, while emphasis on critical thinking was associated with a magnification of gender and minority gaps. They concluded that deemphasizing traditional, teacher–centered instruction is expected to increase average science achievement and minimize gaps in achievement between individuals of different socio- economic statuses.

Kolb (1994), recommended that teachers help students to become critical scientific thinkers by teaching life science through inquiry. Through scientific inquiring, students learn the intricacies of investigations, including experimental design, data collection, data interpretation and explanation and defence of results. Advantages of using the Activity–Based Method in teaching biology practically includes:

1. Students are trained to easily identify problems with local interest and impact.
2. Students are also encouraged to use local resources in locating information that can be used in problem resolution.
3. It also extends the learning situation beyond the classroom.
4. Teaching and learning become more realistic and meaningful to students who explore and share ideas together.
5. High order thinking skills in the context of the problem, rather than seeing problems as separated entities in the school programme is enhanced.
6. Creativity, freedom of expression, initiative and leadership qualities are inculcated into students.

Though the activity-based method is perceived to be one which help students to explore, there are some disadvantages. They include the following:

1. Lesson may take a very long time for students to go through the activity successfully.
2. Students normally become frustrated especially, when they fail to discover or find the solution to a problem.
3. Organizing, managing and controlling of students towards effective achievements of results can be difficult.
4. It can be an expensive method of teaching considering resources, materials and funds to be provided for the learning process.

In spite of the disadvantages of the activity-based method of teaching it enable students have more hands on than minds-on experiences in the teaching and learning of science. The lecture Method is also used in the teaching of biology practical lessons. This method includes the lecture and the programmed instruction. Instructional procedure is a one-way process where the teacher transfers a body of knowledge to students according to a pre-planned scheme. The lesson is teacher-centred and the students are regarded as recipients of instruction. The teacher therefore ignores students in terms of what they might bring to the classroom. The lecture method is also regarded as textbook controlled, which is an inflexible with minimal consideration given to the students' abilities. The teacher only presents his ideas, develops them, evaluate and summarize the main points for the students to listen and prepare their own notes. Advantages of the lecture method as a medium of instruction include;

1. More topics are covered in a relatively short period of time.
2. Students are given good training and insight into the techniques of analyzing issues.
3. The method is very suitable for teaching very large classes
4. It is very easy in using to deliver knowledge. With the advantages stated above this method has numerous disadvantages which makes it unsuitable to use in practical lessons.

Disadvantages of the lecture method include;

1. Lessons, which are not interesting and also very long, may bring about boredom in the teaching process.
2. Class involvement, class participation and process skill development are not encouraged.

3. The method cannot be effective, in teaching some specific concepts and subjects at the senior high school level.
4. Students understanding is rarely-assessed during lectures, because students are not encouraged to participate fully in the lesson.
5. It leads more to rote learning and does not give actual understanding of science concepts.

The debate regarding the nature of practical work (the method of practical work that would suit the learning of science best both effective and affectively) has taken a variety of forms throughout history including “the discovery approach, the process approach and ‘practical work by order’ (Wellington, 2002, p. 56). The discovery approach to practical work was criticized for providing a seemingly false view of science (Kirschner,1992), the idea of reaching theoretical conclusions solely from observations, known as the “inductive process” (Wellington, 2002, p.56). This style is similar to the heuristic approach, become overly focused on the physical application of doing practical work. Instead of understanding scientific concepts it made doing science appear as a method, a set of rules, that could be applied to determine any scientific theory. As Jenkins (1979) explained: “As the concepts and imagery of science were seen to be removed further and further from ‘common sense’ it became increasingly difficult to argue convincingly that students must be put in the position of an original discoverer and to maintain that science owed its achievements to a method which was merely ‘a game’ whose rules could be learnt and applied” (p. 50).

Moreover, there were problems for teachers in applying the approach in science lessons. More often than not, students were unable to observe the desired (or expected) phenomenon. Such problems may have been due to the “fallacies in the assumptions underlying the approach" (Millar,1989, p. 50) rather than the teacher's capability amongst other reasons. To whatever extent the criticisms are placed, there are still a number of experiments with new items of apparatus which have become customary in today's science lessons (Wellington, 2002). Although some recipe method experiments have become iconic of current teaching, there is little acknowledgement that, doing leads to students' understanding or that engagement in science increased with such an approach (Millar, 2004; Woodley, 2009). The process approach, to some extent, had more extensive criticism than the discovery approach (Wellington, 2002; Millar, 1991). The model involved the notion that science could be as set method of discrete processes whereby skills and processes could be separate from the natural theoretical aspects of science (Millar,1991). The approach was trying to provide a science for all abilities. There was the view that if students were less able, learning scientific transferable skills would be more appropriately suited to them, over any scientific content (Wellington, 2002). Such an approach to scientific practical work seemed to provide an unbalanced view of what it meant to study science. Millar and Driver (1987), explained how "the aims should be the development of a deeper understanding of the concepts and purposes of science.

For science, we would argue, is characterized by its concepts and purposes, not by its methods" (p. 56). Furthermore, Gott and Mashiter (1994), noted that "while acknowledging that the methods of science are important, the methods are those of induction and operate within a concept acquisition framework" (p.182). Furthmore, they continue to suggest that this is a possible reason for the possible limitation of practical work in influencing students' attitudes in studying science. According to Chalmers (2006), the modelof science that is constructed within a process approach, such as the Warwick Process Science in 1967, is based on a naïve intuitivism that many view as unsound (such as Leach, Millar, Ryder & Séré, 2000). Moreover, the process approach was teaching skills learnt naturally from a nearly age (Hodson & Bencze, 1998; Millar, 1989; Wellington, 1989), such as observing that a plant grows if it is provided with the right amount of nutrients or the classification of objects according to certain properties. The final approach that Wellington (2002), referred to regarding practical work by order, relates to the more recent situation since the National Curriculum was introduced in 1988. In 1988 the Department for Education and Science stated five components with practical work being included in the form of investigations. Even though the National Curriculum was adapted in 1992, 1995, and 1999, practical work was, and still is, a major part, constituting Attainment Target 1 or later Sc1 scientific enquiry (Jones & Roberts, 2005).

From the 1992 version of the National Curriculum, the problem was regarding discrepancies in the assessment of practical work (Daugherty, 1995). If students were being assessed on their scientific facts, then the question arose regarding what the students were actually investigating and what was being examined. These problems have continually been faced by teachers and have led to criticisms such as those made by Donnellyet al. (1996): What did it test: the scientific idea or the pupil's experimental procedures? If that be the case, the latter, then why makes the linkage to the former at all? And if, as again seems likely to have been the case, the established scientific outcome was clear, in what sense was the investigation open? (p. 47). The nature of the practical work since 1988 has provided one specific model which has been noticed as being flawed by some (Kelly, 1990; Wellington, 2002). Furthermore, the different approaches current teachers use to conduct practical work can have an influence on the learning outcomes. The approaches can be either inductive or deductive in nature with explicit or implicit instructions given by the teacher on conducting the practical work (Hodson, 1990). The National Curriculum for Science has often been remarked as being burdened by too many facts and concepts primarily required for examinations (Gummer & Champagne, 2006). Indeed, SCORE (2008), explained how teachers found the science curriculum content as the major barrier for limiting the amount of practical work conducted.

Furthermore, it has been observed that for some students this focus on content has led them to be disengaged with learning about science (House of Commons, 2002a; Kind & Taber, 2005). From a historical perspective, there have only been three major studies into the nature and purpose of practical work in England and Wales: Kerr in 1963 and Thompson in 1975. Even though their questionnaire-based studies are specific in terms of both cases and times in history, they are continually referred to and analyzed. The studies are primarily used in the debate regarding the nature, aims and purposes of practical work. The missing link between learning biology to pass an examination and learning biology to select a career can be attributed to the need for innovativeness, improvisation and foresight by teachers to consciously expose the students to biology in action through the use of modern teaching aids, application of videos, education tours etc. There is the need by the biology teacher to demystify the teaching and learning of biology and science as a whole and to make the process more interesting and to promote the inquisitiveness of the students. Three areas to be addressed to demystify the teaching and learning of biology and all the sciences and also make the process more interesting are;

1. introducing new ideas, knowledge and educational technologies (including audio-visuals aids)
2. improving the teaching and learning environment 3. embarking on outreach programme.

2.5 The Aims of Teaching and Learning of Biology in Second Cycle Institutions

Education, in general, is the domain through which humans transmit, consolidate, and develop human culture, which is comprised of knowledge systems, science, arts, values, and religions. Jacques Delors, former President of the European Commission, and his colleagues proposed that education be given top priority on national agendas in a study entitled "Learning - the Treasure Within," delivered to UNESCO in 1996. Prioritise education's role in providing citizens with a "passport to life" via which they can learn to be, learn to know, learn to do, and learn to live together (Tobin, 1990).

Human societies' educational efforts have become a vital occupation. In-school education is a full-time work for a huge portion of the world's population (about one billion students and 20 million teachers in 1992), and it takes up one-quarter of each person's life on average. A growing number of people seek some type of out-of-school education throughout their lives. In 1996, the global expenditure on formal education was estimated to be around $1200 billion US dollars (an average 5.1 percent of the world GNP). Despite the fact that this budget represents the greatest investment in many countries' national accounts, it is still deemed insufficient to meet actual demands. With their gaze fixed on the year 2000, a huge number of governments, national and international organizations, and groups engaged in a fashionable exercise during the 1990s. They took part in large-scale conferences with the explicit purpose of assessing past successes and failures, learning from the lessons learned during the twentieth century, and identifying the significant challenges confronting humanity at the turn of the millennium.

The Earth Summit on Environment and Development in Rio de Janeiro in 1992 was the first, followed by the World Population Conference in Cairo in 1994, the World

Conference on Higher Education in Paris in 1998, and the World Conference on Science in Budapest, Hungary in 1999. From these gatherings, a global consensus formed on the importance of education, science, and technology as the primary drivers and determinants of growth. Agenda 21, Education 2000+, Taxonomic Agenda 2000, Species 2000, and the International Geosphere and Biosphere Programme (IGBP), as well as the International Human Dimension of Globalization, were all announced. Scientific and technological advancements have aided in the acceleration of economic, social, and cultural growth in recent human societies. The industrial revolution was aided by developments in physics, chemistry, and engineering in the nineteenth century. Advances in agricultural sciences, physiology, genetics, and plant and animal breeding provided the foundation for the agricultural (green) revolution in the twentieth century; new knowledge in microbiology, immunology, medical, and pharmacological sciences helped reduce disease tolls and resulted in increased life expectancy.

The discovery of the structure and function of DNA sparked a biological revolution that will last well into the twenty-first century. The human endeavour to read the book of life, unravel the complexity of biological systems (molecules, cells, organisms, and ecosystems), and see the oneness of life through the diversity of living forms requires deciphering the genetic code (alphabet). Progress in the biological sciences is allowing humans to not only get a better understanding of the evolutionary processes and routes that led to the present world, but also to significantly alter the direction of biological evolution, including their own. Biological sciences, like other scientific fields, are a part of general human culture, which constitutes a unique evolutionary feature of *Homo sapiens* and marks the boundary between other primate species. Cultural traits (values and knowledge) are inherited and modified (scientific and technical innovations) through education, i.e., the ensemble of learning, training, and research processes, whereas biological traits are transmitted between generations through reproduction and modified through mutation processes.

Biological education, also known as education about life, education through life, and education for life, takes centre stage in all of these processes. During the second half of the twentieth century, significant advances and discoveries in fundamental and applied biological knowledge were accomplished, with far-reaching ramifications affecting practically every element of human existence and society. The invention and application of sophisticated molecular biology tools has resulted in a revolution and the formation of new fields such as Molecular Biology, Molecular Genetics, Molecular Evolution, and Genomics at the micro-level. In our understanding of animal and plant reproduction and development, as well as our understanding of evolutionary processes in general, tremendous advances and breakthroughs have been made. At the macro-level, the creation of sub-ecological disciplines such as Functional Ecology, Landscape Ecology, Global (Biosphere) Ecology, and Ecological Networks is owing to the development of novel concepts, methodologies, and techniques, as well as the use of modelling, remote sensing, and informatics. Biodiversity, bio-complexity, and integrative biology are examples of key multidisciplinary scientific fields that have emerged in the biological sciences.

At the 1992 Earth Summit in Rio de Janeiro, Brazil, a new perception and formulation of the world problem arose, replacing the old and fragmented vision of the difficulties confronting human communities (individually and collectively). There is now a better understanding of the relationships and interconnections between issues affecting human health, food, and the environment, as well as issues relating to agriculture and agro-industry, fisheries and aquaculture, pharmaceutical industry and biotechnologies, pollution (physical, chemical, and biological), and conservation and management of bioresources (deforestation, desertification, soil salinization and loss of biodiversity, etc.) The new dilemma that developed during the Rio Summit is built on a trinity of biodiversity, global change, and long-term development. The need to better understand such issues as the origins, maintenance, and change of biodiversity over space and time scales, the ecosystem function of biodiversity and the many hidden ecological services it provides to humankind (Di Castri & Younès, 1996) was highlighted by the increased awareness of biodiversity at the three levels of biological organization: genetic, organismic, and ecological (Di Castri & Younès, 1996). There is also a rising awareness of the importance of taking into account the human dimension of biodiversity, particularly cultural variety.

At the environmental, economic, and information/communication levels, the second major topic, global change and globalization phenomenon, has been examined. Pollution problems transcend national borders, and global warming and ozone holes have an impact on the entire biosphere. If we are to succeed in addressing these issues, we will need to establish a global coalition with all nations working together. The trilogy's third and final "mot d'ordre" is "sustainable development." Developed during the Earth Summit, this novel concept intends to promote much-needed unity on both a spatial and temporal scale. On a global scale, this entails solidarity between the North and the South, between the developed and wealthy nations and the developing and impoverished countries of the Third World. Furthermore, on a longer time scale, it involves solidarity with future generations, taking into account their well-being and leaving their options open. In order to meet these problems, we need to invest in research, training, and teaching in science, particularly biology, if we are to achieve economically efficient, socially fair, and environmentally sustainable development.

2.6 Hands-on Method in the Teaching and Learning of Biology

Hands-on science is defined mainly as any instructional approach involving activity and direct experience with natural phenomena or any educational experience that actively involve students in manipulating objects to gain knowledge or understanding (Haury & Rillero, 1994). Some terms such as materials-centered science and activity-centered science are used synonymous with hands-on science or terms such as materials-centered activities, manipulative activities and practical activities are used synonymous with hands-on activities (Doran, 1990; Hein, 1987). Unlike the laboratory works, hands-on activities do not necessarily need some special equipments and special medium. According to Jodl and Eckert (1998), hands-on activities are based on the use of everyday gadgets, simple set-ups or low-cost items that can be found and assembled very easily. McGervey (1995) states that "some hands-on activities can be done for less than a dollar per hand, a few have zero cost.

Hands-on activities were perceived as an enjoyable and effective form of learning of almost all the major U.S science curriculum reforms of the late 1960s and early 1970s (Hodson, 1990). Several studies in the literature show that hands-on activities help students to outperform students who follow traditional, text-based programs (Staver & Small, 1990; Stohr-Hunt, 1996; Turpin, 2000), to enhance their understanding and replace their misconceptions with the scientific ones (Coştu, Ünal & Ayas 2007; Ünal, 2008), to develop attitudes toward science positively (Bilgin, 2006), and to encourage their creativity in problem solving, promote student independence, improves skills such as specifically reading, arithmetic computation, and communication (Haury &

Rillero, 1994; Staver & Small, 1990). Lebuffe (1994) emphasizes that children learn better when they can touch, feel, measure, manipulate, draw, make charts, record data and when they find answers for themselves rather than being given the answer in a textbook or lecture.

Hands-on, minds-on" summarizes the philosophy we have incorporated in these activities - namely, that students will learn best if they are actively engaged and if their activities are closely linked to understanding important biological concepts. Activities such as culturing of Rhizopus, salting of meat, using polythene bags/balloons for demonstration of lungs, capturing some living things in their immediate environment, getting the scent of sliced onion and preparing wet-mounts are some examples of hands-on activities that teachers could use in their lessons for learners.

The method utilised to teach knowledge to students is an important feature of science and biology education. During practical exams, students demonstrate that they are unable to make precise observations and document their findings, as well as accurately use rulers for measures. It has been suggested that science education in Ghana has grown more academic than practical. As a result, there is a need to look for more effective tactics that are likely to boost senior high school Biology achievement. The goal of research has been to find more effective and learner-centered teaching methods and practices that will help students achieve higher success in biology. Several science education study studies show that creative teaching approaches and instructional tactics can improve students' achievement and acquisition of science process abilities, as well as increase student engagement and promote the formation of a good attitude toward science learning. Co-operative Learning, Concept Mapping, Peer Tutoring, Computer Assisted Instruction, Blended Learning, and the Investigative Laboratory Approach are some of the innovative teaching approaches and instructional tactics. These creative teaching methods and ideas can be used in biology classes as well. According to research, creative teaching strategies are beneficial in enhancing students' biology learning results.

The biology curriculum in Ghana specifies that biology instruction should be student-centered and activity-oriented. This supports Score's (2008) definition of practical work as any science teaching and learning activity that involves students manipulating and/or viewing real items and materials rather than virtual objects and materials. In this case, the teacher serves as a facilitator. In order to teach and learn biology effectively. As stated in the biology syllabus, Scientific Inquiry Skills (SIS) are a combination of practical and experimental skills that students must develop in order to become excellent biologists. Because these skills are so important to biologists, the biology syllabus includes a unit called scientific inquiry skills in practically every subject to help teachers consciously teach and support certain activities to help students acquire these skills. The presentation of manipulative skills employing tools, machines, and equipment for practical problem solving is part of these practical skill advancements. The curriculum emphasizes that teaching practical skills should include projects, case studies, and field studies in which students are immersed in hands-on work and the search for practical answers to issues and tasks. Experimental abilities include skills in planning and constructing experiments, observation, manipulation, classification, sketching, measurement, interpretation, recording, reporting, and conducts in the laboratory/field that demonstrate scientific inquiry processes. Every learner must master the psychomotor domain, which includes practical and experimenting skills.

As a result, the teacher must ensure that students achieve a high level of expertise in the use of scientific tools and equipment. Handling and using tools and equipment correctly for practical and experimental work. In order to obtain a conclusion, hypotheses must be developed, experiments must be planned and designed, and experimental activities must be carried out with tenacity and, if necessary, modifications. Because of the practical character of the biology curriculum, MOE (2010) set aside three 40-minute sessions per week for practical lessons. If the following issues are considered, the classroom, laboratory, and school environment can be made conducive to the teaching and learning of biology:

- Teachers' ability to improvise by preparing simple models where teaching models are not available, using demonstration and activity kits, and introducing new ideas and technologies (computers and internet) where available in teaching.
- Students' preconceptions and inhibitions (mind-set) that particular subjects or areas are too difficult or unimportant, and that certain themes are not related to the topics to be studied.
- Adequate syllabus knowledge to lessen the contradictory demands and contradictions of the West African Examinations Council (WAEC) and Ghana Education Service (GES) syllabuses, which both seek for complete lesson plans across the board, with key principles taught first;
- Provision of logistical and other instructional materials, such as laptops and projectors; Arrangements for eminent scientists to speak to students about controversial themes in science and society or science in action;

- Experimentation with demonstration should be taken more seriously and handled with vigour, rather than being treated as a series of tasks or games, as it is in GAST textbooks.

Many teachers, according to Adepoju (1991), choose an approach that does not allow students to develop their intuition, creativity, or creative ability. Students' minds must be disabused of the notion of looking for fast fixes to pass their exams rather than following the practical method. Science is a doing subject, according to Young (as mentioned in Sharpe, 2012). He also argued that science is a method of learning about the universe by collecting evidence through observation and controlled experiment. Students should witness and experience biology in action in classrooms, as this will help them choose a career path. As a result, educational visits to various companies, such as Uniliver, a cocoa processing company, and others, to watch and analyse processes and products, as well as the development of industry-specific technology.

2.7 Students' Attitude towards Science Subjects

The attitudes of students toward natural science are an important aspect of science education. Natural science interests few students, and they do not pursue the related science subjects in post-secondary education. Akarsu & Kariper (2013) conducted a survey of high school students' interests and attitudes toward science issues based on their genders, grades, and parents' educational levels. The study's findings revealed that there is a link between students' attitudes toward science and the following variables: science interests, genders, grades, and parents' educational levels. The study also revealed participants' interests in several disciplines of science, as well as their links with criteria such as gender, grade, and parents' educational levels and employment. Students were also discovered to be most interested in general science concepts, with a popularity rating of roughly 50%. This could indicate that kids enjoy science when they are first introduced to basic topics in science. It is probable that this has something to do with how they are presented and the tactics teachers use to teach them.

Many studies have looked into students' attitudes toward science in general (Barmby et al., 2008; Bennett & Hogarth, 2009; Cerini, Murray, & Reiss, 2003; Cleaves, 2005; Osborne Simon & Collins 2003)., as well as how they perceive science in comparison to other issues and subjects (e.g., Barmby et al., 2008; Bennett & Hogarth, 2009), a review of the literature on students' attitudes toward the nature and purpose of practical work reveals that there is no specific research into what students think and feel about practical work, or whether practical work has an affective value in influencing students' decision to continue with science after compulsion. Teachers appear to find practical work motivating, as evidenced by the large amount of empirical data collected by Holstermann, Grube, and Bögeholz (2010). However, straightforward queries about students' attitudes toward practical work, such as "do they love practical work?" are necessary. Is it motivating for them?" (Wellington, 2005) and go deeper into what it is that they are truly inspired to do and why.

Prior to the twenty-first century, the few studies that looked at students' perspectives on practical work seemed to reveal that, while they claimed to love it, they considered it primarily as a means of validating scientific theory and as a teaching approach to keep them from being bored (Denny & Chennell, 1986). According to Driver et al. (1994), the majority of students are unaware of "the objective of practical action, *"the purpose of practical activity, thinking that they 'do experiments' in school to see if something works, rather than to reflect on how a theory can explain observations" (p.*

6). According to Watson and Wood-Robinson (2006), there is a disconnect between what students and teachers think the goals of practical work are. As a result, students would rarely take advantage of whatever effective or emotive impact it might have on their science learning, and cognitive engagement would be limited (Watson, 1994).

Students, on the other hand, “made strong linkages between the teacher's goals and the tasks they were given,” according to Hart et al., (2000), and this had an impact on students' perceptions of science practice” (p. 672). By the year 2000, Hart et al. discovered that children in Key Stage 4 were at an age where social contact was very important, and that students would enjoy the opportunity to connect during practical work. However, as Bennett (2005) explains, this discussion may have been less about discussing the science of practical labour and more about interacting with their social lives. According to Hart et al., (2000), “acting out the role of the scientists helped them obtain a better comprehension than simply reading or talking about it” for the majority of students (p. 671). However, it is unclear whether students had a greater comprehension of scientific principles or the function of a scientist in the practical job they were doing, according to Hart et al. (2000). Hart et al., (2000) discovered that students required to bring some prior knowledge of scientific principles to the practical activity in order to connect well with it. To effectively engage in the process of studying science, students must have a personal interest in practical activity. According to Bergin (1999), students with a low personal interest may enjoy the embellishments of learning, such as practical work, but they will not master the course content, whereas students with a strong personal interest may be annoyed by such embellishments because they do not require the same stimulation to be attracted to the scientific content.

Students who are aware of their abilities, according to Hodson & Hodson (1998), have more control and confidence in their study. As a result, students who have a personal interest and are academically capable may find practical work irritating, especially if their laboratory skills are also of a high ability, as laboratory abilities are required for students to participate effectively in practical work (Hodson & Hodson, 1998). Practical work, according to the House of Commons (2002a) study, is typically dull and demotivating. As a result, many students lose whatever interest for science that they once had. They often study science because it is required of them, but they do not appreciate or interact with the topic. And they form an unfavourable impression of science that may last a lifetime. According to the JCQ (2009b), scientific enrolment has risen in recent years, with biology ranking third among General Certificate of Education Advanced Subsidiary level subjects, with 6.55 percent of all students in England studying the subject, and chemistry placing eighth.

Physics had seen an increase in student numbers, although it was only rated ninth in 2009, with a 4.77 percent gain from 2008. (JCQ, 2009b). According to the data, the recent uptake in biology appears to be significantly greater than in physics and chemistry. Chemistry and physics are, in fact, the two disciplines that have been considered to have the greatest practical work in schools from Year 7 to Year 11 (Abrahams, 2009). According to the House of Commons (2002a), students saw practical work as a useful way of connecting theory and practice, as well as developing manipulative skills. Such goals are comparable to those that Abrahams and Millar (2008) argue can be achieved through good practical labour. Of course, the report found that not all students loved or were driven by practical work, and that a wider choice of practical work approaches was needed to allow students to experiment and investigate more (House of Commons, 2002a). Furthermore, students had difficulty reaching the required result, and some were dissatisfied with practical work that was only in the form of a recipe or for which they already knew the outcome. Students dislike practical labour, according to the House of Commons (2002a), but they should have a variety of fascinating possibilities to experiment and investigate, according to the House of Commons (2002b). Regardless of the obvious shortcomings observed by students at the time, it appeared that professors still viewed practical practice as an important affective aspect of science.

According to Osborne Simon & Collins (2003), 71% of students who stopped studying science thought it was intriguing, and even more importantly, 79 percent thought it was interesting. This could indicate a correlation between practical work and happiness in school science, but not a link to post-compulsion student retention. These findings back up Abrahams' (2009) conclusion that while practical work can make individual science sessions more enjoyable, it is useless for maintaining motivation to study science after coercion or influencing a personal interest in it, despite popular belief. Cleaves (2005) analysed transcripts from four interviews with seventy-two high-achieving secondary school students conducted over a three-year period. Despite the fact that Cleaves' study focused on students' general formation of post-16 choices rather than their views on practical work (a problem with the majority of research studies into such areas), Cleaves discovered that students believed they did less practical work in Year 11 and made comments like the following: I'm not a big fan of science around here. Not all teachers have the ability to keep our attention. The practical is a stickler for details.

We understand that in order to receive good scores, you must include a great deal of detail, but we are not experimenting at the level of the write-up (Cleaves, 2005, p.

476). It is worth noting that the students in Cleaves (2005), who came from six mixed comprehensive schools in England, were far above average in all areas, including science. Given the kids' outstanding academic proficiency in science, it's possible that this element alone could persuade them to stay with science after compulsion, as Cleaves (2005) indicates. Indeed, despite their relatively negative comments, the student described above chose to study science after compulsion, according to Cleaves (2005). Many factors have been suggested as influencing students' decisions to continue with science subjects, such as future career or university aspirations (House of Commons, 2002b), the value students and parents place on the subject's relevance to the students' life (Jenkins & Pell, 2006), and the personality traits of individual teachers and other members of staff that have an impact on students' decisions to continue with science subjects (Jarvis & Pell, 2005; Reiss 2005).

While many students reported to appreciate practical work, Cleaves (2005) discovered that as they went through the schooling system, there was common criticism that there was less time given to completing practical work in science lectures. It appears that, despite their desire to perform more practical work, perhaps because they prefer it to other methods of learning science, students do not believe that what is taught in their classrooms is the best it can be. Furthermore, given the kind of the students engaged, which were higher-ability students, this is a significant discovery, because despite their reservations about practical work, some of them continue to pursue science after compulsion. The effects of practical work on low-ability and dissatisfied science students may encourage them to have a slightly less negative view of science (Abrahams, 2009). More recently, Barmby et al. (2008) found that students' attitudes toward practical work deteriorate marginally from Year 7 to Year 9.

Nonetheless, the study discovered that students viewed classroom science to be monotonous because practical work was required for them to appreciate science and they conducted little. However, it appears that students preferred practical work over other methods of learning science; as one student put it, “I like science when you do practical work rather than when you write stuff” (Barmby et al., 2008, p. 1088). These findings were similar to those of a more recent study by Abrahams (Barmby et al., 2008, p. 1088). Barmby et al., (2008) did not query the students about practical work or what they meant by "boring" because the paper was primarily focused on students' views about science and the apparent change in their attitudes toward science. Furthermore, because the students were asked to rank each of the attitudes measures on a five-point scale (5 = strongly agree, 4 = agree, 3 = neither agree nor disagree, 2 = disagree, and 1 = strongly disagree), a more detailed assessment of students' opinions could only be obtained from the 4% of students who were later interviewed. Furthermore, while using such Likert measures, it is necessary to exercise caution and be aware of the numerous limits that their use entails, as they do not reflect the overarching picture of students' attitudes about practical work in this scenario (Cohen, Manion & Morrison, 2018). The bulk of remarks about students' attitudes about practical work are often discovered as a by-product of examining other aspects of students' attitudes toward science or decision-making post-compulsion, according to the research (such as Barmby et al., 2008; Cleaves, 2005). According to Wellington (2005), we need to ask students more open-ended questions if we want to completely understand why they profess to be driven by and enjoy doing practical work, but so many of them opt not to pursue science after compulsion.

2.8 Challenges Affecting the Teaching of Hands-on Work

According to Kapenda (2008), in some Namibian senior secondary schools, teachers mostly employ the lecture approach, which does not allow students to interact and improve their understanding. Due to reasons such as the lack of chemicals, equipment, apparatus, and laboratories in some schools, teachers are unable to use various instructional approaches. According to Kandjeo-Marenga (2011), most Namibian secondary school science instructors find it difficult to teach practical work due to a lack of laboratories, forcing them to educate through demonstrative methods rather than experiments in order to teach practical work. According to Muijs and Reynolds (2010)), certain teaching factors appear to be linked to learners' positive learning outcomes, such as clearly stating basic competencies; an emphasis on the lesson introduction; the teacher's good subject knowledge; good questioning skills; good time management; effective lesson planning; and good classroom management. Teachers that possess several of the attributes listed above may be able to help their students develop scientific skills. Muijs and Reynolds (2010) go on to say that if teachers encourage social connections, assist learning, and use a variety of teaching approaches in their classrooms, learners' understanding and skill acquisition may improve. The teaching of practical work, according to Jacobs, Vakalisa, and Gawe (2004), is dependent on how science teachers develop and maintain a positive teaching and learning environment in their classrooms. This can be accomplished if the teacher knows how to set up and organize the lab as well as maintain a high degree of discipline among the students during practical exercises.

The lack of chemicals, equipment, materials, and apparatus, on the other hand, is one of the most generally perceived variables impacting practical job education (Jacobs, Vakalisa, & Gawe, 2004; Tsakeni 2018). The lack of teaching and learning resources in schools, such as laboratory manuals, textbooks, chemicals, apparatus, and equipment, has a negative impact on teaching practical work, according to Synder and Voigts (1998). They go on to say that while resources may be enough in some schools, teachers do not use them. Some teachers lack the knowledge and experience needed to teach practical work using various apparatus and equipment. However, some schools' resources are insufficient for imparting practical skills (Synder, & Voigts, 1998). According to Jacobs, Vakalisa, and Gawe (2011), it is critical for a science teacher to understand how to facilitate practical work because knowing suggested practical work in the subject's syllabus is insufficient without understanding how they were carried out. This type of knowledge aids the teacher in devising practical activities for students as well as preparing and setting up relevant materials and equipment for students who must conduct experiments.

Hill (2014) states that schools require teachers who are knowledgeable, have teaching experience, and have the courage to enable practical work. Furthermore, according to Hill (2014), teaching should not just be a means of assisting learning in which students are expected to gain new knowledge, but also a practical experience that can help students build their own knowledge and improve their practical abilities. Practical work cannot be taught if fundamental experimental materials are not available in laboratories, according to Likoko, Mutsotso, and Nasongo (2013). For teaching practical skills, having practical materials and facilities in the laboratories is critical. They go on to say that the quality and quantity of teaching resources can affect students' performances in practical exams. In contrast to poorly equipped schools, learners in schools with adequate facilities tend to score well in examinations (Likoko et al., 2013). Folashade and Akinbobola (2009), on the other hand, believe that ineffective teaching methods in science classrooms, large class sizes, a lack of sufficient funds, insufficient monitoring, and a lack of standard laboratory equipment are among the main factors affecting the teaching of practical work in schools. They go on to say that a teacher's capacity to teach practical depends on the methods he or she employs. As a result, Folashade and Akinbobola (2009) believe that when teachers utilize proper teaching approaches, learners' performances will improve. Furthermore, Mji and Makgato (2006) state that another aspect influencing the teaching of practical work in schools is the usage of the laboratory, which includes the establishment of a teaching and learning environment in the classroom that incorporates instructors' pedagogical knowledge. According to Garcia, Winston and Borzuchowska (2003), teachers' negative attitudes about science can make it difficult to teach practical work in the classroom.

2.9 Review of Related Empirical Studies

Research in science education has established strong positive effects when students are taught using experiential pedagogies. These approaches have been shown to enhance student attitudes (Gormally, Brickman, Hallar, & Armstrong, 2009), improve exam scores (Abdi, 2014), increase scientific process skills (Ergul et al., 2011), and potentially encourage more students to pursue STEM-related careers (van den Hurk, Meelissen, & van Langen, 2019). The body of literature has largely been developed in the Global North, but a recent study (Bando et al., 2019) compiled the results of randomized controlled trials deployed across four Latin American countries, assessing the efficacy of the inquiry-based approach across a total of 17K students. Their results showed a 0.16 standard deviation increase in science test scores after 7 months of practical science learning. There is a pressing need to understand how to contextualize international best practices for African education, given the low learning outcomes presently being recorded here. In the early 2000’s, Ghana began participating in the

Trends in International Mathematics and Science Study (TIMMS). Ghana has continually ranked near or at the bottom of the participating countries (Buabeng, Owusu, & Ntow, 2014). Despite Ghanaian education stakeholders' recognition that improvements in learning outcomes are needed, only a few studies have been conducted to determine the efficacy of experiential pedagogies in the local science education context. One study at the senior high school level (Aboagye, 2009) compared the effectiveness of a particular constructivist approach (the three-phase learning cycle) with the traditional approach used in Ghanaian science classrooms. It was used in the context of teaching one specific topic (direct current electricity). In South Africa, Kibirige, Rebecca & Mavhunga (2014) studied 60 high school students, half of which were undergoing three weeks of experimental work (using standard laboratory equipment) and the other half which were undergoing traditional lecture methods. In both cases, they measured improvement on exam scores as a result of the practical sessions. These studies indicate that experiential pedagogies can improve learning outcomes in the African science classroom

Kankam et al. (2020) investigated how biology practical lessons are conducted in some selected Colleges of Education in Ashanti Region of Ghana. The sample population was made up of 60 students and 12 biology tutors from six selected Colleges of Education. The research findings showed that both tutors and students from the selected science colleges considered practical lessons as one of the effective means of teaching and learning biology. It also came out that, the tutors' pre-activities and teaching strategies in selected science and non-science colleges of education were not different. Again, students from the science colleges tend to have a greater advantage over their counterparts from the non-science colleges, because they were exposed to some other additional strategies. Background to the Study the upgrading of the teacher education certificate programme to diploma advocated the conventional approach to science practical activities and suggested that science practical work should be laboratory based. To achieve this goal, all Colleges of Education had to be provided with laboratories well-resourced with adequate equipment and apparatus. Unfortunately, however, a close observation made about some Colleges of Education in Ghana, revealed that they do not have standard laboratory stocked with adequate equipment and apparatus. Even those having standard laboratories for science teaching, such laboratories were ill-equipped. Other series of observations made about some Colleges of Education also showed that the approach currently being used to teach biology is most often based on classroom work which is intended only to meet examination requirements. Meanwhile, practical work is known to be an essential component of studying the natural environment. The findings clearly indicates that, even at the centre for teacher training, the enforcement of practical lessons was low and as such teachers were highly likely to transfer that adapted behaviour on their students and stick to the use of only theoretical knowledge.

In addition, Tordzro and Ofori (2018) investigated and compared how biology practical lessons were conducted in some well-endowed and less-endowed Senior High Schools in Ghana. The main instruments used for gathering the data for the study were questionnaires, document analysis and informal observation of some biology lessons. The sampled population for the study consisted of 408 students and 24 biology teachers from twelve selected Senior High Schools in the Eastern and Central Regions of Ghana. Data collected were analysed using frequency counts and percentages. The research findings showed that the time allotted to practical lessons in biology varied from one school to another, as 35.8% of students from well-endowed schools complained of insufficiency of time as against 78.9% of students from less-endowed schools. The study also found that the teaching strategies employed in the two categories of Senior High Schools were not different. However, students from the selected well-endowed schools tend to have a greater advantage than their counterparts from the less-endowed schools, as they were exposed to less lecture method 7.4% compared to 27.9% from the low-endowment schools**.** To ensure efficiency in the teaching of the practical aspect of biology in the Senior High Schools, the study recommends that the government and all other stakeholders in education must supply laboratories in all Senior High Schools with the necessary equipment, materials and chemicals to enable students to develop the necessary. The results of this study also bring to light that, the availability of well-endowed science laboratory influences the performances and understanding of students. In view of this, it is very important that much attention is given to the use of hands-on activities to deliver lessons.

(Sharpe & Abrahams, 2020) in their study examined students' attitudes to practical work in biology in secondary schools. The study involved 607 students from Year 7 to Year 10 (aged 11–15) drawn from three state-maintained secondary schools in England. The schools were, broadly speaking, representative of schools in England in terms of academic measures such as GCSE outcomes, value-added performances and socio-economic area. The study found that secondary students' attitudes to practical work were, generally speaking, positive they were not constant and homogenous but change over time. The affective value of practical work was found to vary by subject although in all three sciences this value decreased, albeit at different rates, as students approached their General Certificate in Secondary Education examinations (GCSE) taken at age 16. The study therefore concluded that the affective value of practical work needs to be considered on a subject-by-subject basis, rather than, as is often the case currently in school, in terms of a generic attitude to science practical work. Furthermore, the affective value of practical work can be maximised by using more at the start of secondary education (Key Stage 3 – ages 11–14) with a gradual, subject-specific, reduction as students approach their summative public examinations (age 16) when their preference for non-practical, exam orientated, teaching increases.

Another study in Ethiopia by Daba Sorale & Sultan (2017), assessed the status of Biology laboratory and practical activities in some selected secondary and Preparatory schools of Borena Zone. A random sampling technique was employed to collect data from students, Biology teachers and technicians of the study schools. Structured and semi-structured questionnaires and observation of laboratories and other facility was used. All respondents (100%) from Kilenso School respond as there is no laboratory room while majority of respondents (80.2%) from Bule Hora School respond as they have common laboratory for each science and no separate laboratory for Secondary and Preparatory school. In all schools there is no facility, equipment and chemicals are simply stored in non-ventilated laboratory room due to absence of skilled laboratory technicians and even no cooling system. The current study is similar to report of Hunde and Tegegne (2010) in which Jimma University community school and Yebu School have laboratory which is not functional while Bilida School has no laboratory set up at all. The study is also similar to the report of Tesfamariam et al. (2014) in which most laboratory rooms available in secondary schools of Mekele town were not built for laboratory purpose and lacked even the most facility. Absence of laboratory practical activities makes students at secondary and preparatory schools of the study area lack interest to join science class.

2.10 Research Gap

In the study of Jeronen, Palmberg, and Yli-Panula, (2017), he emphasised on totalising didactic teaching learning process in biology, based on literature reviewed so far, some gaps can be identified in his submissions. Daba, Anbassa, Oda and Degefa discovered that classroom instruction was mostly focused on the cognitive domain, with minimal emphasis on the emotive and psychomotor domains. The current study aimed to close this gap by looking into the effects of teaching biology using a hands-on activity approach on students' biology achievement. Abdisa and Tesfaye (2012) conducted research in Aba Bora Zone Ethiopia to see how guided discovery, demonstration, and traditional teaching approaches affected students' biology achievement. They discovered that among the three methods, the discovery technique was the most effective. The purpose of this study was to look at the impact of using a hands-on method as a guided discovery technique on students' achievement. The current one differs from the previous one in that the locations are different; the previous one took place in Ethiopia, while the current one took place in Ghana. Furthermore, the current's primary concentration was on hands-on labour.

Abdisa and Tesfaye (2012) conducted a critical study in Nigeria on the influence of a question-answer teaching strategy on students' learning gains. The study, like the current one, used an experimental design, while the latter focused on a practical approach. In Turkey, Silay (2010) conducted an experiment on the effects of problem-solving tactics on students' achievement, attitude, and motivation. The most recent one looked at the impact of the practical method on students' achievement and attitude transformation. According to the studies examined, instructional interventions are likely to alter students' achievement as well as their attitude about the subject. However, there are no comparative research on two study groups to examine the effects of hands-on work on students' achievement in Ghana, particularly in the Northern sector of Ghana. The current study was designed to fill this gap.

2.11 Conceptual Framework

According to Katane and Selvi (as cited in Copriady, 2014), competency is a set of knowledge, skills and proficiency in creating a meaningful experience when organising an activity. "Competence is best described as a complex combination of knowledge, skills, understanding, values, attitudes and desire which lead to effective, embodied human action in the world, in a particular domain" (Devlin, 2008). It is against this concept that this study is built on. From the researcher's construct, the effective merging of biology practice in education has a high influence on the academic performances of students and it even improves the acquisition of process skills. In view of this the concepts compare two research groups, one would be influenced with practical knowledge and the other be left with only theory. The perceived outcome is that those with practical set of skills would perform better than those without practical skills set.

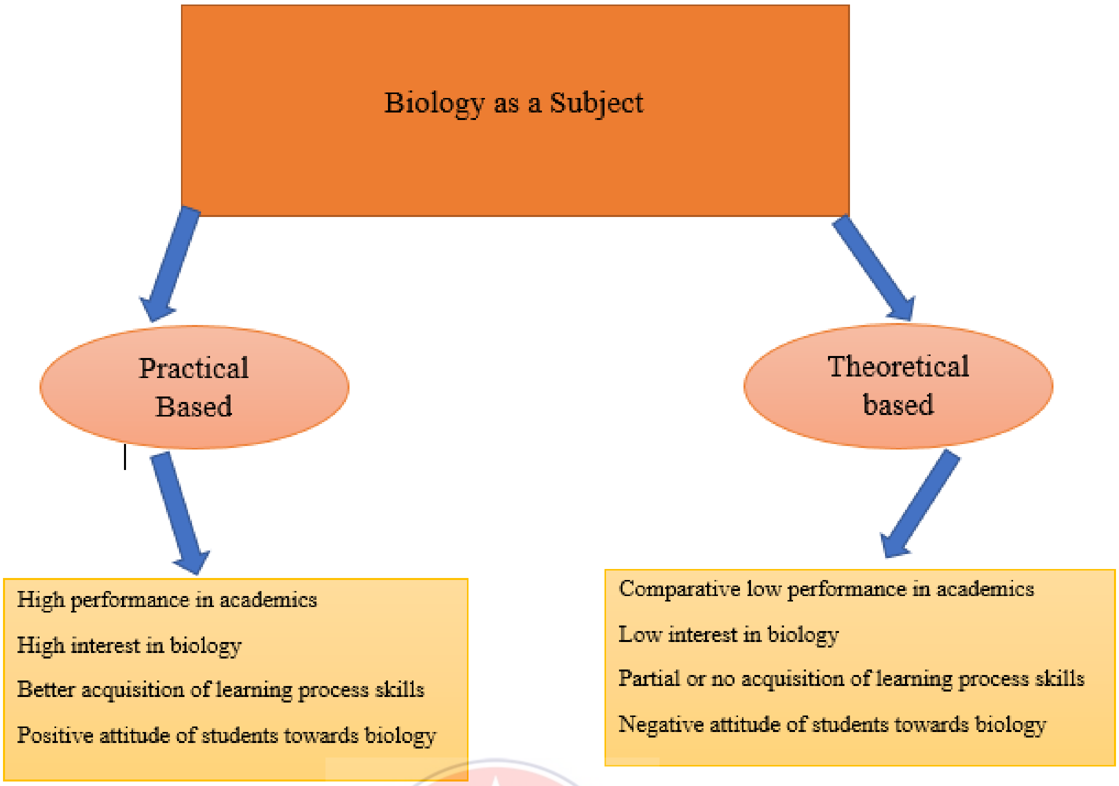

Figure 2.1: Conceptual framework
Source: Researcher's Construct, 2021.

The framework above clearly explains the view of the researcher on the entire study. This means that if the mode of delivery is Practical-Based, it will have direct consequence and further influence on students' performances, attitude and interest in the subject.

CHAPTER THREE

METHOLOGY

3.0 Overview

This chapter was devoted to the following: design of the study, population and sampling procedure, instrumentation, reliability and validity of data collection instruments, pilot testing, data collection, and analysis.

3.1 Research Design

The main design adopted for this study was action research design. Action research is an extended form of case study in that it studies a particular population to improve or solve the problem with an appropriate intervention (Creswell, 2016). The performances of a class of students was studied to identify an appropriate intervention of using hands on activities in biology lessons. The research made use of hands-on activities in teaching some selected topics in biology as intervention, and the pre- and post-treatment tests were used to ascertain the effect of the hands-on activities on students' performances in the selected topics in biology.

The results of the post intervention test will aid the researcher to test the hypotheses of the performances of the study group. The students' responses to the questionnaire's items were used to discuss and analyse the perception of the effectiveness of hands-on activities on the teaching of biology in the school. The study groups' response to the questionnaire was also used to determine the effect of hands-on activities on students' attitude towards biology. Teachers' responses to the questionnaire were also used to get their perspective about the effect of hands-on activities on students and the challenges the science teachers face in incorporating hands-on activities in their lessons

3.2 Population and Sampling Procedure

3.2.1 Population

In this study, the population was all science students in Nadowli/Kaleo district and the target population will consist of all science students in Queen of Peace SHS. However, due to resource constraints and covid-19 restrictions, the accessible population to the researcher was 45 elective biology students and the 9 biology and integrated science teachers in Queen of Peace SHS.

3.2.2 Sampling

Methodologists have written excellent discussions about the underlying logic of sampling theory (Babbie, 2007; Fowler, 2018). According to Creswell (2014) "in many experiments, however, only a convenience sample is possible because the investigator must use naturally formed groups (e.g., a classroom, an organisation, a family unit) or volunteers. In this study which is an action research design, Queen of Peace Senior High School which run a pure science programme in the Upper West Region was selected using the convenience sampling technique and the focus was on the form one science classes that offer biology. In all, the researcher used 45 elective biology students of form one and 9 science teachers (biology and integrated science) from the study school took part in the study.

3.3 Instrumentation

The main instruments used in this study included a set of pre- and post-treatment test (Selected Topics in Biology Achievement Test (STBAT)) items as well as student questionnaire and questionnaire for biology teachers. The STBAT scores for pre-intervention and post-intervention were generated and analysed to answer the research question one; "What is the effect of hands-on activities on students' performances in selected topics in biology? Also, students were given questionnaire to answer in addition to the achievement test, this enabled the researcher to answer Research Question 2 and 3. Questionnaires distributed to Biology and Integrated science teachers were used to answer research questions 3, & 4.

The general benefits of questionnaire which include consistency of presentation of questions to respondents, the assurance of anonymity for the respondents and the less time it takes to administer (Muijs, 2004). On the other hand, the disadvantages are that they often have low response rates and cannot probe deeply into respondents' opinions and feelings (Cohen Manion and Morrison 2018; Alhassan and Abosi 2014; Muijs 2004), but this was not the case because sample size was manageable.

The questionnaire for both students and teachers contained some closed-ended items and respondents was required to choose from and open-ended items to allow respondents to formulate their own answers. The researcher used both open-ended and closed-ended items in the questionnaire because respondents are more inclined to answer close-ended items and open-ended items provide a greater depth of responses since there was a standardized answers to the responses.

3.4 Scoring the Questionnaire Item

A five point/option Likert scale (strongly Agree (SA), Agree (A), Neutral (N), Disagree (D) and Strongly Disagree (SD)) was used to score the questionnaire items. The items in the questionnaire were positively and negatively worded in order to minimize participant satisfying responses. Positively worded items (e.g. "students have a change of attitude about biology when hands-on activities are used during instruction in any biology topic") were scored as follows:

Response Intensity	Symbol	Score
Strongly Agree	SA	5
Agree	A	4
Neutral	N	3
Disagree	D	2
Strongly Disagree	DA	1

Negatively worded items (e.g. using hands-on activities hinders students' acquisition of process skills") were scored as followed:

Response intensity	Symbol	Score
Strongly Agree	SA	1
Agree	A	2
Neutral	N	3
Disagree	D	4
Strongly Disagree	DA	5

Likert scale was used to score the questionnaire items because it looks interesting to respondents and people often enjoy completing the scale of this type (Muijs 2004). The two important feature of an attitude scaling instrument, should be measuring only one thing at a time. Indeed this is a cornerstone of Likert's own thinking Cohen Manion and Morrison (2018). Again Likert scale is easier to construct, interpret, and provides the opportunity to compute frequencies and percentages as well as statistics such as the mean and standard deviation of the scores. This intend allow for more sophisticated statistical analysis such as analysis of variance (ANOVA), t-test, chi-square, and regression analysis (Sharon Golden. 2017, Muijs, 2004,). Additionally, Likert scales are often found to provide data with relatively high reliability (Sharon Golden. 2017; Oppenheim, 2001).

3.5 Validity and Reliability of Instrument

The quality of research instrument or scientific measurement is determined by both validity and reliability (Aikenhead 2020). Validity and reliability have different meanings in quantitative, qualitative and mixed methods research. It is important not only to indicate these clearly, but to demonstrate fidelity to the approach in which the researcher is working and to abide by the required principles of validity and reliability (Cohen Manion and Morrison, 2018). Cohen Manion and Morrison (2018) further assets that a piece of research is valid if the warrants that underpin it are defensible and, thereby, if the conclusions drawn and the explanations given can stand their ground in the face of rival conclusions and explanations; validity and warrants are linked intimately. Validity seeks to determine whether the instrument actually measures what it intends to measure and reliability on the other hand refers to the consistency of the data when multiple measurements are gathered (Gott, Duggan, Roberts, & Hussain, 2019).

The instruments for the study were designed to explore how the use of hands-on activities as an intervention to enhance students' performances in teaching selected topics in biology. Therefore, the expertise of Science Education lecturers from the department of science education was sought to validate the instrument for content and face validity of the instruments.

Also, the West African Examinations Council (WAEC) syllabus and the Ghana Education (GES) Service syllabus for biology for senior high schools were used as a guide to carefully craft the students' achievement tests and both the students' and teachers' questionnaire to ensure adequate reliability and content validity of the research instruments.

The required content materials for the selected topics were extracted from the Ghana Association of Science Teachers (GAST) Biology and other recommended biology textbooks. The extracted materials were used to prepare student and teacher-centred Instructional Strategy Package. The research instruments consisted of student's achievement test items (pre and post-test) on selected topics and questionnaires.

The validation of the content material as well as the students-and-teacher centred instructional strategy package were carried out through the assistance of some experts in biology education in the department of Science Education of the University of Education, Winneba. The validators were asked to determine the appropriateness of the content material and to find out whether the instructional package be used to achieve the purpose for which it is designed for was okay. The recommendations of the validators were used to revise the content material and the instructional package. These were followed by a trial test of the instructional package through a pilot test in another school of similar characteristics with the study school.

Reliability is about the consistency in a research result. If the survey or research were to be conducted again, will it yield the same or similar results? Reliability of data can be assessed if the items are examined to show internal consistency.

3.6 Pilot Testing

A pilot test of the instrument was carried out in another school in a different district with similar characteristics as the study school. The pilot school had thirty 30 science students in form one during the third term in the 2020/2021 academic year. This pilot test was to establish the reliability of the students' achievement test and questionnaire for both students and teachers. Also the pilot test helped identify defective items in order to avoid any ambiguities that might occur and get an idea of the expected responses before administering them to the participants of study groups. The pilot test was done to enable the researcher to detect the weaknesses in the research instruments and correct them. The pilot test was done two months prior to the actual intervention and data collection to ensure that all weaknesses observed in the instruments during the pilot study were addressed in order to revise the instruments to improve their reliability.

After the pilot test, a pre- and post-test items internal consistency were determined with a Cronbach alpha values of 0.77 and 0.82 respectively for the test retest reliability co-efficiency. Usually a high reliability value (0.79) and (0.84) for the pre-test and post-test respectively is expected to be obtained with the use of Cronbach's alpha computation relation,

$$\alpha = \frac{N\bar{c}}{\bar{v} + (N-1)\bar{c}}$$

Here N is equal to the number of items, $\bar{c}$ is the average inter-item covariance among the items and $\bar{v}$ equals the average variance. Alternatively, the Cronbach's alpha can also be defined as the internal consistency of individual factors that are used to measure a theme. In simple terms it is known as the scale reliability.

3.7 Data Collection Procedure

Hands-on, minds-on" summarizes the philosophy we have incorporated in these activities - namely, that students will learn best if they are actively engaged and if their activities are closely linked to understanding important biological concepts. Three hands-on instructional techniques namely culturing of *Rhizopus* to prepare a temporary slide on the *Rhizopus*, preparation of yam cups for demonstration of osmosis, and capturing a lizard (male and female) and bringing them to class were employed to teach three selected topics (Preparing a temporary slide/ wet-mount, Life processes of Living things/Lizard and Demonstration of Osmosis in living tissues/yam cups) for a period of one month. Each activities was meant for a particular topics. Hands-on activities in general means learning by experience. Students handle scientific instruments and manipulate the objects they are studying (Ruther ford, 1993). It is assumed that working in a hands-on way provides a more realistic and exciting experience of the content (Franklin and Peat 2005; Nott and Wellington 1996). Most empirical studies provide evidence for the assumption that conducting hands-on activities leads to positive motivational outcomes (Özlem and Eryilmaz 2011). Vogt, Upmeier zu Belzen, Schröer, & Hoek, (1999) investigated how interesting specific phases of the biology lesson were perceived to be by students. Phases that contained topics of relevance for students or practical work, for instance conducting experiments or working with microscopes, were rated as highly positive. Similarly, Renner, Abraham, & Birnie, (1985). Interviewed students about their feelings regarding learning activities like laboratory work. They identified laboratory work as being 'interesting' as compared to other more 'boring' instructional formats like watching films or listening to the teacher. Thompson and Soyibo (2002) presented students with two different conditions within their chemistry classes.

The students in this study were actively involved in setting up the equipment and apparatus as well as collecting specimen to be used in the laboratory, during the hands-on activities.

It took two 2 weeks to carry out the activities for each topic as part of the intervention process. In all six (6) weeks (one month two weeks) was used for the entire intervention for the selected topics. A pre-intervention assessment was done with study class and marked over 60marks. Then student were taken through the various activities hands-on activities under each of the selected topic. After each hands-on activity in each topic, an intense class interaction and discussion followed and was led by the teacher in this case the researcher. In the case where the hands-on activity was an experiments: experimental procedures, data collection, manipulation and analysis procedures were reviewed before the students wrote their laboratory reports.

At the end of the 6 six weeks of engagements, the students were assessed with an equivalent post treatment test which was marked and scored over 60marks as the pre-intervention test. The 45 students also answered the students' questionnaire and the 9 biology and integrated science teachers also responded to the teachers' questionnaire. The data collection and analysis for each research question is illustrated in the table of metrics below.

Table 3.1: Data Collection Procedure/Analysis

	Research Question	Source of Data	Data Collection Technique	Data Analysis Technique
1	What is the effect of hands-on activities on students' performances in selected topics in biology?	Students (Pre-and post-test)	Selected Topic in Biology Achievement Tests (STBATs) (Pre-and post-test) from study group	t-test statistic
2	What is the effect of hands-on activities on students' attitude towards selected topics in biology?	Students and Teachers	Questionnaire administration	(Standard deviation and mean)
3	What is effect of hands-on activities on students' acquisition of process skills?	Teachers	Questionnaire administration	(Mean Standard deviation (SD),
4	What the challenges biology teachers face in organising hands-on activities?	Teachers and Students	Questionnaire Checklist	Thematic analysis (Frequency, Mean and Standard deviation

3.8 Data Analysis

This research employed both quantitative and qualitative (mixed) methods of data analysis. The pre-intervention and post intervention test scores of study group were analysed quantitatively using t-test statistic to determine the effect of hands-on activities on students' performances in the teaching of selected topics in biology. The rest of the research questions analyses were analysed on a 5-point scale of Strongly Agree (SA), Agree (A), Undecided (U), Strongly Disagree (SD) and Disagree (D). Values 5, 4, 3, 2, and 1 respectively were assigned to them. Mean scores of 3.00 and above shows acceptance (Agree) while mean scores below 3.00 were interpreted as Disagreement/ non-acceptance.

3.9 Ethical Issues

I secure a letter of introduction to the study school to enable me have access to the have the approval of the Headmaster of the school. After getting the approval from the head of the school, the HoD organised the students for me to them what I was there for. I explained to them that I was conducting a research and wanted them to be participants. This actually was ensure informed consent which is required. I ensured that prospective participants of the study were made aware of the purpose of the study and their rights as participants to withdraw at any point guaranteed.

Anonymity/confidentiality clause was also ensure in the tests as well as the in questionnaire for both students and teachers. I assured them that, data collected shall be used for the purposes of the study and not for any other thing.

CHAPTER FOUR

PRESENTATION OF FINDINGS

4.0 Overview

In this section of the study, findings from the field of study would be critically analysed and placed in context with the literature reviewed for the study. Possible agreement and disagreement to build concepts would be clearly indicated and given a better alignment of the current study in theory. It is however important to note that, respondents selected for the study included both students and teachers who offer and teach biology as a subject. In view of this, data concerning these two groups of respondents would be duly presented.

4.1 Socio-Demographic Features

To understand the dynamics of respondents' input to the study, it was important that, the researcher collected data on demographic features. On the part of students, the main features examined include the gender of respondents, their age and grade attained from the Basic Education Certificate Examination (BECE). More so, the main demographic features of teachers that were examined includes the gender of teachers, their area of specialization, year group taught as well as their level of qualification.

4.1.1 Gender of students

Gender as used in this study simply refers to the biological classification of humans into male and female. Table 4.1 presents a summary on the frequencies of each gender among students sampled for the study.

Table 4.1: Students' Gender Classification

Factors	Frequency	Percentage
Male	23	51.1
Female	22	48.9
Total	**45**	**100**

Source: Field of Study, 2021

Out of the 45 students sampled, 23 of them were male representing 51.1% while the remaining 22 were females representing 48.9% (Table 4.1).this Figure was not surprising to achieve, this is because various studies over the years have indicated that science has been one of the male domineering area of study. In view of this, it will be very obvious to walk into a science class containing few females.

4.1.2 Age of students

The ages recorded for students represent the current age in years as at the time of data collection. For easy description of data, the ages recorded were grouped into four classes. These classes include those between 13-15 years, 16-18 years, 19-21 years and 22-24 years (Table 4.2). Table 4.2 indicates the age range of students.

Table 4.2: Students' Age

Factors	Frequencies	Percentage
13-15 years	9	20
16-18 years	29	64.4
19-21 years	5	11.1
22-24 years	2	4.4
Total	**45**	**100**

Source: Field of Study, 2021

Nine respondents were found to be between the ages of 13-15 years, representing 20%. Also, 29 respondents were noted to be between 16-18 years representing 64.4% of the total student sample (Table 4.2). Additionally, 5 respondents were identified to be between 19-21 years representing 11.1%. The remaining 2 respondents were noted to be between 22-24 years representing 4.4% (Table 4.2). From the data presented, it can be said that majority of the student sample were between the age of 16-18 years with the least population falling between 22-24 years. According to the Ghana Statistical service and the Ghana Education Service (GES), the average entry age for senior high school is 16 years. This then explains the reason why majority of the student populace were found within this age range. The slight minority who are above this age can be attributed to delay in school attendance as well as repetition.

4.1.3 Students' entry grades

The entry grades of students into the second cycle institution were assessed. This provides relevant data on the standard achievement of students examined for this study. Nonetheless, the grades recorded do not necessarily reflect the current academic capacity of students. Table 4.3 indicates the entry grade of the students

Table 4.3: Entry Grades of Respondents

Grades	Frequency	Percentage
06-10	0	0
11-15	6	13.3
16-20	19	42.2
21-25	16	35.5
26 and above	3	6.6
Total	**45**	**100**

Source: Field of Study, 2021

From Table 4.3, no student was recorded to have achieved a grade score of 6-10 in their BECE. However, 6 respondents were noted to have achieved between 11-15 representing 13.3% while 19 students achieved a grade score between 16-20 representing 42.2%. In addition to this, 16 respondents achieved a score between 21-25 representing 35.5% of the student sample for the study. The remaining 3 respondents were recorded to have achieved a grade score of 26 and above. Irrespective of the flaws of many students, respondents indicated that, majority of the students sample achieved a grade score between 16-20.

4.1.4 Gender of teachers

As indicated in table 4.4, the gender classification of teachers was also collected and analysed. Table 4.4 below presents the number of male and female teachers in the science field within Queen of Peace Senior High School. Table 4.4 shows the gender of biology and integrated science teachers

Table 4.4: Teachers' Gender Classification

Factors	Frequency	Percentage
Male	8	88.8
Female	1	11.2
Total	**9**	**100**

Source: Field Study, 2021

Eifght teachers sampled for the study were males while the remaining individual was a female representing 88.8% and 11.2% respectively. Just as indicated before, females in the field of science are comparatively few to males and enhance, having few female science teachers in the second cycle institution is of no surprise. According to Appiah (2013), there exist some sort of prejudice concerning the education of science. Most often it is been said that it is a difficult field that inconvenient females. This in the scope of the study, explains why there is a few records of females engaged in the field of study.

4.1.5 Subject taught by teachers

In this section, the subject or specialisation of teachers examined for this study was examined. This provides the study with much information about the abilities of teachers and their interest in guiding students through biology hands-on activities. Table 4.5 indicates the subject taught by the respondents.

Table 4.5: Teachers Specialisation or Subject Taught

Subject	Frequency	Percentage
Biology	4	44.4
Integrated Science	5	55.6
Total	**9**	**100**

Source: Field Study, 2021

From table 4.5 above, 4 teachers were identified to be specialist in biology. This means that 44.4% of the total teachers sampled for the study majored in biology and hence possess much expertise in the field. More so, it can be said that, due to their long service in teaching, they have accumulated much experience that would aid them in the execution of educational duties. The remaining 5 teachers were identified to be teachers of integrated science and not biology per say. Nonetheless, since biology forms a part of the integrated science syllable, it is no mistake to take their views on the subject under discussion. It is important to note that these 5 individuals represent 55.6% of the sample of teachers selected for the study.

4.1.6 Years of Teaching Experience

As teachers serve longer in the field of duty, their level of experience begins to increase and as a result they develop diverse teaching techniques. In view of this, the study in this section examined the level of experience among the sampled teachers to give a better background of their level of expertise. Table 4.6 shows number of years of teaching experience of the respondent.

Table 4.6: Years Taught by Teachers

Years	Frequency	Percentage
1	6	66.7
2	0	0
3	3	33.3
Total	**9**	**100**

Source: Field of Study, 2021

Table 4.6 indicates that a total of 6 teachers have had a year experience in the teaching of science and biology as a whole. This represents a total of 66.7% of the total teachers sampled for the study. The remaining 3 respondents indicated that, they have had at least 3 years working experience in the delivering of knowledge with regard to science education. This means that all of the teachers sampled have had some sort of experience in the act of teaching with some substantial number of them possess more than two years' experience in the field of teaching.

4.1.7 Entry behaviour of students taught

Even though students have been made to state the grade acquired during their BECE, teachers were also examined on this phenomenon to access their level of knowledge about the students they teach. Table 4.7 indicates the entry grade/behaviour of students taught.

Table 4.7: Average Student Entry Behaviour

Grades	**Frequency**	**Percentage**
6-10	0	0
11-15	8	88.9
16-20	1	11.1
21-25	0	0
26 and above	0	0
Total	**9**	**100**

Source: Field of Study, 2021

Per data in Table 4.7, 8 teachers asserted that the average entry grade of their students were grade 11-15 representing 88.9% of the teachers sampled. Also, the remaining individual asserted that students in his/her class possess an average grade entry of 16-20, representing 11.1%. Even though students indicated grades between 21-25 as well as 26 and above, teachers were unable to state that as an entry grade.

4.2 Outcome of Pre and Post Test Intervention

Based on the existing problem, the researcher developed an effective intervention plan that was aimed at assisting students to be acquainted with at least three set of hands-on work. This intervention was aimed at identifying the achievement change that would happen as a result of engaging in the intervention process. Below is a summary of the intervention test result. Figure 4.1 below shows the pre-intervention test results of the students.

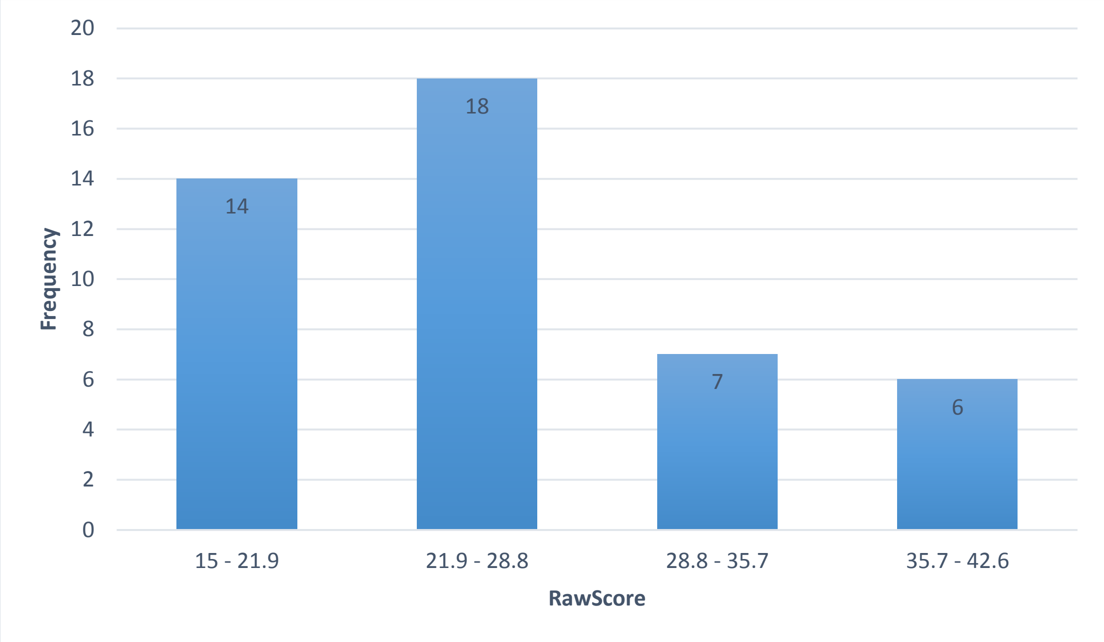

Figure 4.1: Pre-Intervention Test Results
Source: Field of Study, 2021

The achievement test was conducted on the following topics: *Preparing a temporary slide/ wet-mount using Rhizopus, Life processes of organisms/Lizard* and Movement of substances in and out of cells (Osmosis: d*emonstration of Osmosis in living tissues/yam cups)* and scored over 60marks. Due to the nature of the achievement test scores, the raw scores were grouped into four categories. From Figure 4.1, 14 students were identified to have scored a mark between 15 – 21.9 representing 33.3% of the students sampled for the study. Also, 18 respondents representing 40%, were noted to have scored a mark between 21.9 – 28.8. Comparing the frequency of this score to others, it can be said that majority of the students sampled scored a mark within this grade range.

Additionally, 7 students also scored a mark between 28.8 – 35.7, representing 15.6% of the sampled students for the study. The remaining 6 respondents were noted to be between 35.7 – 42.6, representing 13.3%. Per observations, not too many students were able to score a very good score. This pre-intervention strategy is what informed the research to undertake a study on how the involvement of Hands-on activities in the second cycle institutions.

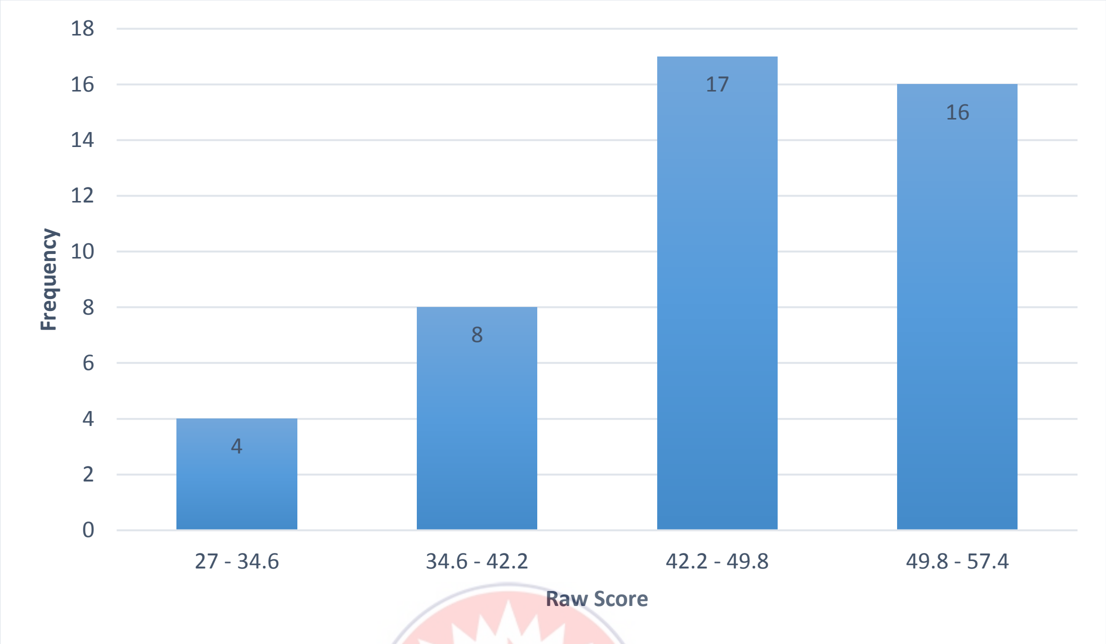

Figure 4.2: Post Intervention Test Results
Source: Field of Study, 2021

Figure 4.2 provides a summary of the test scores recorded after the implementation of the interventional plan. The test achieved a high rating of scores as compared to the pre-test result. It can be said with all confidence that, students performed much better compared to when whey they had not been exposed to the practical bit of the topics they were accessed on. This simply confirms the hypothesis that was set for this study that, students perform better when they are exposed to hands-on activities. From Figure 4.2, a total of 4 respondents were identified to have scored a mark between 27-34.6 representing 8.9% of the students sampled. This means that just a hand full of participants scored marks that were less than half or a little above half of the total marks allocated for the post test. This is a significant results worth praising the impact of the intervention process. Additionally, 8 respondents representing 17.8% of the total students sampled for the test scored between 34.6 – 42.2. This is a significant improvement on test scores compared to the pre-test. In the pre-test, this was the range of mark which was adjudged the highest performances of students. Nonetheless, in this post test results, it is noted as the second least scores of students.

More so, a total of 17 student respondents were noted to have scored between 42.2 – 49.8 representing 37.8% of the total number of students sampled for the test (Figure 4.2). This test score group represents the second-best performances of students in the post test. More so, this test score recorded the highest number of students. This means that majority of the students sampled scored a mark within this set margin. Comparatively, no single students was able to attain this score in the pre-test scores. This signifies an improvement in the performances or achievement of students. Therefore, the study can conclude that, hands-on activities has a significant impact on the achievement of students and hence must be an important practice that must be incorporated in the teaching of biology in senior high schools. In addition to this, a total of 16 respondents were noted to have scored a mark between 49.8 – 57.4, representing 35.6% of the entire students sampled for the study (Figure 4.2). This group of scores represents the best scores attained by students, more so, a lot of students were able to attain a mark in this group of test scores. This adds up to the impact resulting from the structured intervention for students.

Research Question 1. What is the effect of hands-on activities on students' performances in the teaching of selected topics in biology?

4.3 The Difference between Pre-Test Scores and Post-Test Scores

In this section of the study, the researcher compared the outcome of the two tests conducted as part of the intervention implemented to aid students improve on their academic performances to ascertain whether or not there exist some significant difference. More so, this test would enhance the researcher's ability to answer the hypothesis set for the study.

Table* 4.8: *t-test Scores

Intervention	N	Mean	SD	Df	t-crit	p-value
Pre-Test	45	25.56	49.02	44	2.01	0.05047
Post-Test	45	45.87	59.57			

Source: Field Study, 2021

From Table 4.8, the results for the pre-test (M = 25.56, SD = 49.02) and post-test (M = 45.87, SD = 59.57) intervention results indicates that the utilisation of hands-on activities in biology education has a significant effect on the academic performances of students, t(44) = 2.01 p = 0.050. This indicates that the utilisation of hands-on activities in teaching biology has a positive significant effect on the academic performance of students. Statistically, when the p-value is less than or equal to the α-value ($0>P\leq0.05$), the null hypothesis is rejected and the alternate hypothesis is accepted. With respect to this study, (t(44) = 2.01; p = 0.050= α=0.05), that is, the p-value is equal to the α-value which gives enough evidence to reject the null hypothesis. Significantly, the current study supports the claims of (Hart et al, 2000; Cleaves, 2005; Akarsu & Kariper, 2013) that constant engagement of students in hands-on activities in biology results in better performances of students and acquisition of scientific process skills.

Research Question 2. What is the effect of hands-on activities on students' attitude towards selected topics in biology?

4.4 Effects of Hands-On Activities on Students' Attitude towards Selected Topics in Biology

Students' ability to understand some topics in Biology is dependent on several factors. One of the factors examined in this study is the judicious use of practical activities. A t-test statistic has been conducted and the results showed a significant difference in conducting hands-on activities to not conducting hands-on work. However, in this section, the personal views of students were examined to give further clarification to the factor examined. The responds from this Likert scale were analysed using mean scores. The mean determinant for this analysis on the measuring scale is 3. This means that any value less than 3 is in agreement to the assertion examined. Also, values greater than three depicts a level of disagreement to the assertion. It is important to note that, standard deviation scores were also used to describe the cluster of the individual scores around the mean score for an assertion.

Table 4.9: Hands-On activities' effect on Students' Attitude

Statement	**Mean**	**SD**
Using hands-on activities improves your performances in topics biology	4.36	0.48
I get better understanding of biological concepts when hands-on activities are used to teach the concepts	4.24	0.43
I am able to express my ideas and analysed situations very well after hands-on activities are used to teach to biological concepts	4.29	0.46
I get to understand how some biological concepts work in everyday life during the use of Hands-on activities in biology lesson.	4.34	0.48
The use of hands-on activities in biology lesson helped change my attitude towards some topics in topics in biology.	4.51	0.55
I am usually enthusiastic and motivated when Hands-on activities are use in the teaching and learning of taught biological concepts.	4.33	0.48
The use of hands-on activities during instruction in biology reduces my person interactions with my colleagues.	1.04	0.82
The use of hands-on activities in instructional technique is an effective strategy for students of all ability.	4.49	0.51
The use of Hands-on activities as instructional strategy would promote students' understanding of biological concepts and do away with rote learning as well as memorisation of facts.	4.38	0.53
The use of hands-on activities in biology lesson would enable me interact with my colleagues to promote group discussions.	4.36	0.49
Hands-on activities during biology lessons make me feel more involved in the teaching learning process.	4.24	0.43
The use of Hands-on activities as an instructional method in biology lessons reduces forgetfulness and recitation of mnemonics as well as acronyms during examinations.	4.29	0.46
I think engaging on hands-on activities in biology is a waste of time.	1.82	0.58
Hands-on activities hinder students' ability to learning more content in biology.	1.60	0.65
I always enjoy the lesson anytime the teacher makes use of hands-on activities.	1.31	0.47
I was glad if we do hands-on activities in all our lessons in biology.	4.40	0.50

Source: Field Study, 2021

From Table 4.9, respondents indicated that they strongly agree that engaging in hands on activities influence their performances for the better. This assertion was supported with a mean score of 4.36 and a standard deviation score of 0.48. The standard deviation score clearly indicates that there exist a close cluster of the individual responds around the mean score. Most importantly, the study adds to the findings of Akarsu and Kariper (2013) on the factors that influence students' performances in selected topics in Biology. In their study hands-on activities were not recognized as influential factors, however, it has been significantly indicated by this study as an important variable. More so, respondents further pointed out that, they do not just develop interest for some selected topics in biology but they also gain in-depth understanding of biological concepts when they are engaged in practice. A mean score of 4.24 was recorded in support of this assertion representing a strong agreement. In addition, a standard deviation score of 0.48 was recorded to depict a close cluster of the individual variables around the mean score. Barmby et al. (2008), in their study also pointed out this same fact. Comparatively it can be said that the current study is strengthening the position of hands-on activities improving the understanding of basic concepts in Biology.

Additionally, respondents were examined whether or not they are able to express their ideas well after a hands-on activity. Results from the field of study indicates that respondents strongly agreed that their ability to express vividly their ideas and concepts learned are efficiently enhanced. A mean score of 4.29 was recorded to prove the assertion made. A standard deviation of 0.46 indicating that the individual responds are not too far away from the mean score. This is exactly what Watson and Wood-Robinson (1998) indicated to be missing among science students. They believe that, students lacked the ability to develop ideas from theory. However, the findings of this study provide a solution to this long-defined problem among students. In simple terms it can be said that, in order to develop the creative writing of students and influence their ability to produce theoretical views on concepts more practical activities need to be conducted. Again, respondents further indicated that they strongly agree to the fact that they are able to understand how some biological factors work in real life. A mean score of 4.34 was recorded in support of the assertion examined with a standard deviation of 0.48. This means that majority of the individual scores were packed around the mean score and this represents a true reflection of the sampled respondents. Hart et al., (2000) indicated in his study that, students' ability to incorporate scientific theory in real life event is very critical to developing their interest, cognitive abilities and creativity levels. In view of this, the study asserts that, students who are continuously exposed to hands-on activities are able to link them with real life events.

Cleaves (2005) states clearly that topics in Biology are interconnected and can be better be understood when they are treated as a whole rather than a distinct entity. Based on this, the current study assessed whether or not the involvement of students in hands-on activities during lessons can boost their interest for other related topics in Biology. Respondents confidently indicated that they strongly agree that involving students in a hands-on activity in a topic in biology will go a long way to motivate students to yearn for more. A mean score of 4.51 and a standard deviation of 0.55 was recorded in support of the claim. This simply imply that majority of the responds were clustered around the mean score. More so, students posited that they strongly agree to the fact that they are highly motivated to learn more when they are actively engaged in a hands-on activity. To confirm this assertion, a mean score of 4.33 and a standard deviation score of 0.48 was recorded. This indicates that, respondents will lose interest in the subject if engaging activities are not designed to assist them in studies. Barmby et al. (2008), in their study indicated that, aside close factors such as students' friends, study materials and parents, one important factor to boost their interest was the engagement in practical. This means that, the current study in its own way is throwing more light on the importance of hands-on activities and the way it encourages students to learn more.

Studies have shown that, engaging students in activities while they learn limits the frequency with which they interact with friends and subsequently get distracted (Abrahams, 2009). The study examined this assertion in the scope of the study area. Respondents subsequently disagreed that their engagement with friends or colleagues is reduced through the introduction of hands-on activities/works. With a mean score of 1.04, respondents registered their dismay about the assertion under scrutiny. This means that, if students are going to be focused in a practical exercise, they need to be self-disciplined. A strict supervision of activities from facilitators can go a long way to reduce the level of distraction during practical work. Additionally, a standard deviation score of 0.82 was also recorded, indicating a slight dispersion of the individual scores away from the mean.

Students vary in terms of their learning abilities and needs. In view of this, teachers are mostly admonished to use diverse techniques in delivery the same concept in a class in order to reach to all students with diverse learning abilities. Based on this, the study examined feasibility of hands-on activities as a module to address the learning needs of all kinds of students. With a recorded mean of 4.49, respondents strongly agreed that through the effective implementation of hands-on activities, students of all abilities benefit. A standard deviation of 0.51 was recorded indicating the strength in the collective view of responds (mean). Furthermore, respondents asserted with strong agreement that, the effective use of Hands-on activities in the teaching of biology does away with rote learning. This means that, students now come to terms with the actual meaning of a concept rather than memorizing its meaning. Osborne Simon & Collins (2003), in their study indicated that students are able to explain concepts in Biology, Physics as well as Chemistry not just because they memorized it but because they had first-hand experience with the concept. The current study therefore supports the claim of Osborne Simon & Collins (2003). In support of this a mean score of 4.38 and a standard deviation of 0.53 was recorded in support of the assertion made.

Focus group discussion is an effective tool to share ideas and learn from peers in a comfortable manner. Many studies have suggested the use of this technique to help students who feel comfortable in learning from their peers rather than their facilitators. In view of this, the study examined how practical work can encourage group discussion and further improve the performances of students. Respondents further asserted that practical activities encourage them to discuss ideas with their peers and improve their performances in the subject. This explains why respondents disagreed that hands-on activities reduce discussion or interaction among colleagues. With this known, the researcher can confidently indicate that, the interaction among students during practical activities is in a positive direction. A mean score of 4.36 was recorded in support of the assertion indicating a strong agreement to the assertion examined. More so, a standard deviation of 0.49 was recorded indicating that all individual responds were not too far from the mean score. In addition to this, respondents further asserted that, they strongly agree that, the use of hands-on activities in the teaching of biology encourages their involvement in the teaching process. Cleaves (2005), suggested in his study that, activities that aim at effectively involving students promote their ability to learn fast and easy. The current study therefore supports this claim through the assertion of respondents on the subject matter. A mean score of 1.24 and a standard deviation score of 0.43 was recorded in support of the claim.

The teaching of biology entails the use of various acronyms and mnemonics. In view of this, the study examined how hands-on activities can promote the understanding of popular acronyms and terms used. Respondents out of experience indicated that, the effective use of practical activities promote students to remember used acronyms and mnemonics. This means it enhance their ability to learn easy without memorizing these terms. As stated earlier, learning process that involves active memorization leads to forgetfulness. In view of this, the study can emphatically state that students would be able to learn and retain concepts rather than forget with the use of Hands-on activities. This was supported with a mean score of 4.29 which suggest a strong agreement to the assertion with a standard deviation of 0.46. Nonetheless, respondents strongly disagreed to the fact that engaging in hands-on activities is a waste of time. A mean score of 1.82 was recorded in disagree with the claim and a standard deviation of 0.58 which indicates a close gathering of the individual responds disagreed with this factor under examination. From the result, it can be stated that, students have come to understand the benefits associated with hands-on activities outweigh its cost or disadvantage. Therefore, it would be unacceptable to say that engaging in it is a waste of time.

To complement, the above factor, respondents further disagreed that, hands-on activities hinder students' ability to learn more content in biology. A mean score of 1.60 which indicates a strong disagreement to the assertion raised was recorded. In support of this a standard deviation score of 0.65 was also recorded indicating a close cluster of the individual scores around the mean. This simply denotes that; students do not see their involvement in hands-on activities as a hindrance to their academic performances or excellence. Most importantly, it has been already established by respondents that, they are able to learn difficult terms and concepts in biology through their engagement in practical activities hence it would be contradictory to state that it does not. However, respondents strongly agreed that, they enjoy biology class anytime their facilitator uses hands-on skills to deliver or explain a concept. A mean score of 4.31 was recorded in support of the claim with a standard deviation score of 0.47. This means that the individual responds are not too far away from the mean score. Lastly, respondents confidently indicated that they would be glad if all lessons in their biology class are practically delivered. This means that, students are over rating practicality over abstract teaching. Therefore, it is importantly clear that hands-on activities in science lesson delivery be highly encouraged. A mean score of 4.40, indicating a strong agreement to the assertion and a standard deviation of 0.50 was recorded in support of the assertion.

In all the factors examined in this section, the study can only agree with Cohen, Manion and Morrison (2017) on their assertion that, the ability of students can be best experienced when they are exposed to practical work. This means that, their performances, achievement, understanding and retention abilities can be significantly improved when students are engaged in hands-on work.

Research Question 3: What is effect of hands-on activities on students' acquisition of process skills?

4.5 Practical Work's Effect on Acquisition of Process Skill in Biology

In this section of the study, respondents were be assessed on their views on the effect of hands-on activities on their acquisition of process skill in Biology.

Table 4.10: Respondents Acquisition of Process Skills

Factors	Mean	SD
My practical skills have been developed through the use of hands-on activities in the biology lessons.	4.36	0.48
My experimental skills have been developed through the use hands-on activities in the biology lessons.	4.38	0.49
Through hands-on activities, I can now properly handle equipment and use tools and equipment for practical and experimental work with ease.	4.40	0.54
I can now do development of hypotheses, planning and designing of experiments, persistence in the execution of experimental activities, modification of experimental activities where necessary, in order to reach conclusion.	4.60	0.65
I can draw a clearly and well labelled diagram or make graphical representations in relation to the issue at hand.	4.58	0.50
I am able to present clear and precise reports on projects I undertake. Reports orally or written, in concise, clear and accurate manner.	4.62	0.49
I am able to; observe safety measures in the laboratory, care and have concern for the safety of myself and for others, work alone and with others, be economical with the use of materials, ensure clean and orderly work area, persist in achieving results, ensure creative use of materials.	4.44	0.50
I am able to: evaluate data in terms of its worth, good, bad, reliable, unreliable, etc., make inferences and predictions from written or graphical data, extrapolate, and derive conclusions.	4.69	0.56
I am able to make accurate use of measuring instruments and equipment for measuring, reading and making observations.	4.38	0.49

Source: Field Study, 2021

From Table 4.10 above, respondents strongly agreed to the assertion that their practical skills have been improved through their engagement in practical work. With a mean score of 4.36 and a standard deviation score of 0.48. This means that respondents are highly confident that when they continuously engage in hands-on activities, their practical skills was sharpened. It is widely known that, when an act is repeatedly done, it becomes part of an individual. This has been significantly demonstrated by respondents in connection to the examination of this assertion. More so, respondents further asserted that, they strongly agree that their experimental skills have significantly improved. This means that respondents were able to undertake experiments on their own without assistance from a facilitator due to their continuous exposure to practical knowledge. A mean score of 4.38 and a standard deviation of 0.49 were recorded in support of the factor examined (Table 4.10).

In every laboratory, handling of equipment and tools used for experiments are significant to the execution of an experiment. In view of this, respondents further asserted that they strongly agree that their ability to handle scientific apparatus in the biology laboratory has improved due to their exposure to practical work. This means that, students who are not exposed to practical work would have some difficulty in handling lab tools and equipment. In support of this, a mean score of 4.40 and a standard deviation of 0.54 was recorded in support of the assertion under scrutiny (Table 4.10). More so, respondents further indicated that they are able to develop hypotheses, plan and design experiments, execute experiments, modify experimental activities where necessary, in order to reach conclusion. These are essential skills that are expected to be acquired by every science study. In so doing, respondents of the study have indicated that they are able to perform all these duties because of their engagement in Hands-on activities. A mean score of 4.60, indicating some level of agreement towards the factor under scrutiny. A standard deviation value of 0.65 was recorded presenting a close cluster of the individual responses around the mean score (Table 4.10).

Additionally, respondent agreed with some level of certainty that they can draw graphical representation of data and as well label specimen displayed in a science lab.

This ability has been nurtured through the exposure of students to practical activities. A mean score of 4.58 was recorded in favour of this assertion indicating some level of agreement. In addition to this, a standard deviation score of 0.50 was also recorded to depict a close cluster of the individual responds around the mean score. This means the mean is a true representation of the majority view of respondents. More so, students' ability to write pertinent and precise reports on projects were examined. Students therefore posited that they agree with some level of certainty that they can now write these reports due to their exposure to hands-on work. A mean score of 4.62 and a standard deviation score of 0.49 was recorded in support of the assertion. It is important to note that, without these abilities, Cleaves (2005), claim that students' performances in practical work would be affected. In every end of term assessment, practical work form part of students' assessment and hence their mastery of reports would go a long way to boost their test scores.

Safety precautions in the science lab is very important not only to students but facilitators and other users of the lab. In view of this, it is very important to acquaint students with these measures to ensure that they are well vest in them to use the lab on their own. Based on data collected on the field of study, students asserted that they strongly agreed that they are able to observe safety measures in the laboratory as well as show concern for the safety of others. A mean score of 4.44 was recorded in support of the assertion together with a standard deviation score of 0.50. This critically indicates that, the current study supports the findings of Barmby et al. (2008) in the position that, early exposure of students to hands-on work better acquaints them with laboratory rules and regulations. Respondents further indicated that they agree with some level of certainty that, they can now assess the worth of data collected in a practical activity and make accurate inferences from the data. This skill enables students to predict outcome of an experiment and work towards achieving the predicted outcome. A mean score of 4.69 was recorded in support of the assertion made by respondents. More so, a standard deviation score of 0.56 was recorded to explain the level of dispersion of the individual responds around the mean score. Lastly, respondents asserted that they are able to use measuring instruments and equipment to make accurate reading and measurement. A mean score of 4.38 was recorded indicating a strong agreement to the assertion and a standard deviation of 0.49. This means that the individual scores are closely clustered around the mean.

4.6 Teachers' Perspective on Practical Activities

The study after assessing the perspective of students on the effect of hands-on activities on their academic performances and interest in biology, teachers' perspective was also assessed. This helped the study compare the notion of the two active players in the field to determine the intensity of the effect. The scale of measure on this theme was evaluated using the five-point Likert scale. In view of this, the calculated mean determinant is 3.

Table 4.11: The Perspective of Teachers

Factors	Mean	SD
Students cannot do well without engaging in Hands-on activities.	4.33	0.50
Hands-on activities are very essential for sustainable academic growth of students.	4.22	0.44
Hands-on activities enhance students' intellectual ability.	4.44	0.53
Through lessons Hands-on activities, students learn to behave and work like scientists.	4.56	0.53
Through Hands-on activities, students learn to appreciate the role of science and scientists.	4.33	0.50
Hands-on activities give training in problem -solving, thus promoting self-reliance.	4.67	0.50
Training in laboratory using hands-on activities helps students to develop skills necessary for more advanced study and research.	4.56	0.53
Hands-on activities promote better understanding and interest in biological concepts.	4.56	0.73
Hands-on activities provide training in acquisition of science process skills.	4.67	0.50
Hands-on activities do not have much effect on students' performances in Biology.	1.33	0.50
Students still perform well in exams even when they are not taught using hands-on activity method.	3.86	0.88
Students can still learn science process skills without engaging in hands-on work.	1.00	1.22
Hands-on work is not very important in Biology.	1.67	0.50

Source: Field of Study, 2021

Based on the data collected from teachers on their perspective of practical work on the achievement of students, teachers strongly agreed with a mean score of 4.33 and a standard deviation of 0.50. This means that teachers are of strong conviction that students would find it difficult to perform better without the inculcating of practical work in the delivery of education. This supports the findings of Abidi (2014); who indicated in his study that, students who are instructed through activity-based learning achieved higher scores than the ones who were instructed through traditional methods (Abdi, 2014). More so, teachers asserted that, hands-on work has a substantial influence on the academic growth of students. This was supported with a mean score of 4.22 and a standard deviation of 0.44. This simply denotes the level of importance teachers place on the regular practice of hand-on activities in biology teaching. According to Tsakeni (2018), that is the main purpose of engaging students in hands-on activities in relation to science topics. It can therefore be stated that the current study is in support of the findings of Tsakeni (2018).

It is important to note that, teachers also strongly agreed to the assertion that hands-on activities enhance the intellectual ability of students. This was significantly supported with a mean score of 4.44 and a standard deviation score of 0.53. The standard deviation score simply explains how clustered the individual scores on this factor around the mean score are. Kankam et al. (2020) agrees with this assertion and stated with much equivocation that, practical work expose students to tangible knowledge and a means of proving theory with the right tools and equipment. Additionally, teachers agreed with some level of certainty that with constant practice of hands-on activities, students begin to think and act like scientist. This was also supported with a mean score of 4.56 and a standard deviation of 0.53. This simply implies that students was able to work out theoretical concepts that are thought in class and approve their validity and contribute to knowledge where unverified. Kankam et al. (2020) further stated in his study that, students in well-endowed schools are made to think like scientist due to their frequent exposure to practical work as compared to their counterparts in less-endowed schools. This means that, Kankam et al. (2020) believes that, the continuous engagement of students in practical work irrespective of where they are coming from, would reorient them to think like scientist.

The mentality to appreciate science in real life was acknowledged by students as an important effect of hands-on activities on them. In this same regard, teachers agreed with a strong conviction that, students are able to appreciate science as they get more exposure to the usage of hands-on work. This was supported with a mean score of 4.33 and a standard deviation score of 0.50. More so, the ability to present solution to life challenging issues is one of the core objectives of every branch of science. It is the same with biology, the proposal of solutions to problem is paramount and as such teachers agreed with some level of certainty that students are given training in problem-solving skills. This was supported with a mean score of 4.67 and a standard deviation of 0.50. Akindjide et al. (2021) firmly agrees with this assertion and further compares the development of a nation to the acceptance and appreciation of science concepts among students. They believe that, when students begin to appreciate findings from science, they would themselves develop theories that would seek to provide solutions to existing problems in their community.

More so, teachers acknowledged that; hands-on activities in the teaching of biology enhances the ability of students to develop skills necessary for more advanced studies and research. This assertion was supported with a mean score of 4.56 which represents agree on the measurement scale. A standard deviation score of 0.53 was also recorded indicating a close cluster of the individual scores around the mean score. Tordzro and Ofori (2018), appreciated the fact that the conduct of recent research into existing world problem are mostly done through hands on activities and hence agrees with the findings of the current study in the fact that engaging students in hands-on activities equip them for future research duties. Furthermore, teachers agreed with some level of certainty that hands-on activities encourage the interest of students in biology as well as their understanding of concept in the subject. Just like students, teachers believe that it is important to make hands-on activities a priority if you want to increase the interest of students in the study of biology. This is in line with the finding of Tordzro and Ofori (2018) and explains the reason behind the low performances of some students in science related course. . A mean score of 4.56 was recorded in support of the claim while a standard deviation score of 0.73 was recorded to indicate the dispersion of individual scores around the mean score. Per this rate, the dispersion is not too far away from the mean score.

Additionally, teachers were of the same view as students on the fact that; students are able to acquire scientific process skills through their involvement in hands-on activities. A mean score of 4.67 was recorded in support of this claim and a standard deviation score of 0.50. This simply indicates the effect of hands-on activities on students. Most importantly, this effect has been noted by teachers and to some extent, it can be said that; teachers would be highly motivated to continue engaging students in this activity. It is further reiterated in the findings of Daba et al. (2016), that for students to gain process skills, they must be engaged in consistent practical work. Nonetheless, teachers disagreed that the involvement in hands-on activities has no effect on students. This was also supported with a mean score of 1.33 which represents disagreement in the measuring scale for this factor. More so, a standard deviation score of 0.50 was also recorded in support of the mean score indicating a close cluster of the individual scores around the mean. Certainly, it can be said that, teachers have been consistent with their claim that practical activities have a significant effect on the performances of students and subsequently boosting their interest in the subject. Both Tordzro and Ofori (2018) and Akindjide et al. (2021), believes that practical activities has a gross effect on students' interest in science and hence it would be a misplacement of belief that it does nothing to promote the interest of students in the subject. This means that the findings of the study in line of this factor is in line with that of Tordzro and Ofori (2018).

On the issue of performances, teachers disagreed on the fact that non-involvement in practical activities may have no effect on students. A mean score of 3.86 was recorded, which is approximately equal to 4 and represent a level of disagreement on the factor under examination. This solidifies the claims of teachers on the fact that, the performances of students will significantly change if they are engage in hands-on activities in Ghana. A standard deviation score of 0.98 was recorded which also indicates that the individual scores are not too far away from the mean score. Additionally, teachers disagreed that students will still be acquainted with hands-on/practice skills if they are not engaged in hands-on work. Certainly, teachers believe that for one to be more familiar with scientific process skill, they must be engaged in hands-on activities. This was supported with a mean score of 2.00 and a standard deviation of 0.98. Tesfaye (2012) also believes in this fact and explains that students who do not perform well in science practical exams are mostly not exposed to practical work.

Lastly, teachers strongly disagreed that hands-on activities is not important in biology. As a matter of fact, an agreement to this assertion would destroy the facts built up through the study. Hence it was only prudent that, teachers unanimously agree with students on the fact that practical skills are essential component of biological education. This was supported with a mean score of 4.67 and a standard deviation score of 0.50. Recent studies have shown that, practical work has an important role in the teaching of science related courses at all levels of education (Daba, Anbassa, Oda and Degefa, 2016; Tesfaye 2012; Kankam et al. 2020).

Research Question 4: What are the challenges biology teachers face in organizing hands-on activities?

4.7 Challenges Faced by Biology Teachers in Organising Hands-On Activities

Irrespective of the fact that both teachers and students are of the same view that, hands-on activities have an effect on the performances of students as well as their interest in the subject. Teachers continue to face some challenges in the implementation of hands-on work in the teaching of biology. All these challenges have been themed and tallied from the responses of the teachers in connection with how individual teachers stated their challenge. Therefore, Table 4.12 below presents a summary report on the challenges asserted by teachers.

Table 4.12: Challenges faced by Teachers in Organizing Hands-on Activities

Factors	Frequency	Percentage
Inadequate time for teachers	6	66.7
Inadequate knowledge of hands-on-activities on the part of some teachers	7	77.8
Refusal to release funds	7	77.8
Absence of Lab Technicians	8	88.9
Large Class size	3	33.3
Inadequate equipment	7	77.8
Fear of not achieving objectives	2	22.2
Sophisticated Equipment	1	11.1

Source: Field of Study, 2021.

From Table 4.12, the common challenges faced by teachers have been clearly identified and tallied with regard to the number of teachers who assert the same challenge. Specifically, 6 teachers representing 66.7% indicated limited time allocated to teachers for the execution of hands-on-activities as a major challenge. This means that, teachers do not get the required estimated period to take students through the systematic procedure of embarking on a scientific experiment or Hands-on activities in their lessons. In view of this, the regular engagement of students in hands-on activities is highly limited. Science practical requires a lot of time to enable both the teacher and student to setup apparatus as well as go through the procedure for the experiment (Folashade & Akinbobola 2009). In view of this, the allocation of time if not enough would pose a great challenge to students and teachers as well. This places the findings of this study in line with that of Folashade and Akinbobola (2009).

It is important to note that, Muijs and Reynolds (2010) indicated in his study that some teachers pose a major threat to the implement at ion of hands-on activities. In connection to this, seven teachers representing 77.8% of the sampled teachers indicated that the inadequate knowledge on hands-on activities on the part of some teachers possess a great challenge to the execution of hands-on work. It is important to note that more than half of the teachers sampled agreed to this challenge and hence it must be treated as an urgent problem of concern. This certainly means that, the current study supports the findings of Muijs and Reynolds (2010) and places major emphasis on the importance of equipping teachers with the needed knowledge and enhance the occurrence of practical in senior high school. Some teachers wrote indicated *inadequate knowledge in organising hands-on activities* as a challenge.

Furthermore, seven teachers representing 77.8% of the sampled teachers indicated that the refusal of school funds managers/Heads to release funds stands an impediment to the progress and organisation of hands-on activities. This many teachers stated comments such as "*Heads of schools' refusal to release for some hands-on activities" "lack of funds" and "inadequate funds"* as a challenges preventing them from incorporating hands-on activities in their biology lessons. Availability of funds is an essential component that would enhance the frequency with which practical work would be done, however, if funds are not released, teachers would be unable to purchase materials that are needed for the undertaking of research or experimental work. Tsakeni (2018), in his cross-sectional study further indicated that the availability of funds to science teachers is an important factor that can enhance the engagement of students in practical activities. However, in cases where the funds are delayed or denied students are deprived on that experience. In view of this, the study agrees with Tsakeni (2018) that; unavailability of funds is a major challenge of the conduct of practical activities. Also, eight teachers representing 88.9% indicated that the unavailability of a lab technician also poses as a challenge to the conduct of practical work in Biology. In most instances, lab technicians serve as experts who provide assistance to students on the procedure in engaging in practical work as well as acquainting student s with the needed safety guidelines. However, their unavailability would certainly prevent teachers who do not possess great knowledge on practical activities ignore it entirely. Tsakeni (2018) also indicated in his study that, the operation of a science lab requires the skill of an experience and well trained technician. In their absence, the operation of the lab would be a challenge and this is what the study projects and supports.

Additionally, three teachers representing 33.3% indicated that the size of class prevents them from engaging their students in practical work. It is known that the size of a class has an effect on the ability to undertake proper and adequate hands-on lessons. However, the average class size recorded in this study is 25. Therefore, it would be deceptive to use class size as a challenge to the conduct of practical activities in the school under study Likoko, Bakari, and Ndinyo (2013) and have indicated earlier that, the size of a class is always critical to the manner with which students understand things. This acknowledges the fact that, the findings of the current study support the findings Likoko, Bakari, and Ndinyo (2013) However, if teachers are using this as a generic statement, then it can be applicable in most instances. Majority of the sampled teachers further indicated that insufficient laboratory equipment is a contributor to the challenges of teachers to frequently undertake hands-on activities. For example one of the teachers made comments such as "*no laboratory technician or absence of laboratory technician makes it difficult for the teachers to organise hands-on activities.*" A total of 7 teachers representing 77.8% agreed to this fact. Kandjeo-Marenga (2011), in his study identified this same challenge as a major threat to implementing practical activities in teaching biology.

Lastly, two teachers representing 22.2% indicated that the fear of not achieving an objective pose as a challenge to the conduct of practical work. Aside engaging students in practical work, science teachers are also entangled with the objective of completing the syllable for the year or term. The respondents made such comments as "*overloaded syllabuses*" as challenge. Placing the two at pair, teachers some time neglect the practical aspect with the fear of not accomplishing the set objective for the term. This was clearly indicated in the study of Russell & Weaver (2011) and Sandi-Urena, Cooper and Stevens (2011). It can be said that the findings of this current study is in line with them. More so one teacher indicated that the existence of sophisticated machines in biology labs serve a challenge to teachers. The teacher made the point *sophisticated machines and equipment and materials* as a challenge for teachers in incorporating hands-on activities in their biology lessons. Though hands-on activities do not require the use of sophisticated machines and equipment but cheap and locally made items, the teacher may occasionally use such complex and sophisticated machines if the need be. This posits as a complement to the claim of sampled teachers that some teachers do not possess knowledge on hands-on activities and the unavailability of laboratory technicians. This is because if complex machines are installed in a laboratory and there is no well-trained individual who has much knowledge on the operations of the machine. Students would be prevented from using it entirely. As indicated earlier, Tsakeni (2018) believes in the same fact and hence makes it an important factor to consider the recruitment of lab technicians in other to assist in the handling and use of these sophisticated equipment.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOPMMENDATIONS

5.0 Overview

In this section of the study, key research findings are summarized to give a brief gist of the main outcome of the study. Based on these outcomes, conclusions are drawn and further recommendations are made for continuous professional practice as well as future research into the field of biology education.

5.1 Summary of Key Findings

In the process of impacting scientific knowledge in students, various methods were been adopted. In all these methods, researchers over time examine their effectiveness and how they affect the performances of students. In view of this, this current study examined how hands-on activities can influence the academic performances of students. The study adopted Queen of Peace Senior High School as its principal study area with high focus on elective biology students. Forty-five students were sampled in addition to nine teachers who teach science in the school. Students were engaged in a four weeks interventional period and accessed at the end of it all.

It was found that, students sampled for the study on an average agreed with some level of certainty that; engaging in hands-on activities during biology lessons significantly influence the academic performances of students. More so, students indicated that the acquisition of process skills is predominantly dependent on the continuous engagement in hands-on activities. Evidently, students posited that, they had petty items that are required to engage in hands-on work.

Additional, before the enrolment of the intervention plan, students were examined and it was achieved that more than half of the students sampled could not score more than half of the total score of the pre-test. Nonetheless, after the implementation of the intervention plan, students displayed a higher achievement of marks in the post intervention test. This informed the researcher's decision to undertake a t-test statistic to confidently identify the difference between the two test scores and also give answer to the hypothesis raised in the research. The study found that, there indeed exist a significant difference between the scores attained in the pre-test and the post-test intervention. This therefore throws light on the assertion that there exist a significant impact of hands-on activities on students' achievement.

Lastly, teachers were also examined on their perspectives on the effect of hands-on activities on students' academic performances. It was found that, teachers collectively agreed that the engagement of students in hands-on activities results in high academic performances. Nonetheless, teachers asserted some challenges that deter them from embarking on these hands-on activities. Some of them include; lack of funds, inadequate time for teachers to engage in practical work, unavailability of lab technicians as well as the existence of sophisticated equipment. Some teachers also pointed out that, teachers' lack of expertise in practical work deter them from engaging students in biology practical work.

5.2 Conclusion

Based on the findings outlined, the study can conclude that, to achieve better performances of students in biology, hands-on activities must be effectively utilized and that, hands-on activities in Queen of Peace Senior High was not frequently done hence their abysmal performances in the subject. The study found out the acquisition of process skills is predominantly dependent on the engagement in hands-on activities. Also, the interest of students in the study of biology can be highly increased through the effective utilization of hands-on activities. In other words, it can be said that, majority of students who do not have interest in the subject are because they are always taught in abstract rather than engaging them in hands-on activities that would boost their interest in the field of study. Significantly, it can be concluded that teachers of biology possess a positive perception about the impact of Hands-on activities on biology teaching and its subsequent effect on the performances of students. Lastly, the study draws conclusion on the issues that challenge the conduct of hands-on work in biology as; lack of funds, unavailability of laboratory technicians, inadequate lab equipment, and inadequate knowledge of teachers on hands-on activities as well as inadequate allocation of instructional time.

5.3 Recommendations

The study recommends the following points based on the conclusions drawn from the study to aid in the effective teaching of biology:

1. Teachers in the second cycle institution who are in-charged of biology class should utilize hands-on activities as compared to abstract teaching.
2. Also, school management board must allocate enough funds to support the conduct of hands-on activities as well as releasing the funds on time.
3. School management board must also consider the hiring of experienced lab technicians to assist the conduct of practical activities.
4. The district, municipal and regional directorate of education must intensify monitoring on the judicious use of science resource centres.

5.4 Suggestions for Further Studies

Additionally, the study recommends the following areas for future research purposes;

1. Further studies should be conducted on the impact of facilitators' knowledge on the conduct of hands-on work.
2. A cross-sectional investigation into the impact of hands-on activities on branches of science.
3. The impact of students' interest in science on the sustenance in scientific field career.

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APPENDICES

APPENDIX A

STUDENTS' QUESTIONNAIRE

THE EFFECT OF HANDS-ON ACTIVITIES ON STUDENTS' ATTITUDE TOWARDS SELECTED TOPICS IN BIOLOGY AND ACQUISITION OF PROCESS SKILLS

Dear Respondent,

Thank you for being one of our students in this school to have accepted to take part in this study and for taking time to complete this questionnaire. Please respond to each of the items to the best of your ability. Your thoughtful and truthful responses was greatly appreciated. **Your individual name or any identification number is not required and will not at any time be associated with your responses.** All responses was completely **confidential** and so feel free to provide honest feedback. Your responses will help us improve our teaching and learning environment.

Please read the following sentences and kindly provide the information required.

NAME OF SCHOOL……………………………………………………………………….

General Instruction

Please indicate you response by ticking [√] the appropriate bracket or column and fill in the blank spaces provided where applicable.

A: BIODATA

1. Gender a**) Male** [ ] b) **Female** [ ]
2. Age …………………………years
3. What is your entry qualification in the school (State grade attain at BECE ………………………)

B. EFFECT OF HANDS-ON ACTIVITIES ON STUDENTS' ATTITUDE TOWARDS SELECTED TOPICS IN BIOLOGY.

Please indicate you response by ticking [√] the appropriate or best option applicable to statement provided.

Rating scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD)

Statement	SA	A	N	D	SD
4. Using hands-on activities improves your performances in topics biology					
5. I get better understanding of biological concepts when hands-on activities are used to teach the concepts					
6. I am able to express my ideas and analysed situations very well after hands-on activities are used to teach to biological concepts					
7. I get to understand how some biological concepts work in everyday life during the use of Hands-on activities in biology lesson.					
8. The use of hands-on activities in biology lesson helped change my attitude towards some topics in biology.					
9. I am usually enthusiastic and motivated when Hands-on activities are use in the teaching and learning of taught biological concepts.					
10. The use of hands-on activities during instruction in biology reduces my person interactions with my colleagues.					
11. The use of hands-on activities in instructional technique is an effective strategy for students of all ability.					
12. The use of Hands-on activities as instructional strategy would promote students' understanding of biological concepts and do away with rote learning as well as memorisation of facts.					
13. The use of hands-on activities in biology lesson would enable me interact with my colleagues to promote group discussions.					
14. Hands-on activities during biology lessons make me feel more involved in the teaching learning process.					
15. The use of Hands-on activities as an instructional method in biology lessons reduces forgetfulness and recitation of mnemonics as well as acronyms during examinations.					
16. I think engaging on hands-on activities in biology is a waste of time.					
17. Hands-on activities hinder students' ability to					

learning more content in biology.					
18. I always enjoy the lesson anytime the teacher makes use of hands-on activities in the lesson.					
19. I will be glad if we do hands-on activities in all our lessons in biology.					

C. EFFECT OF HANDS-ON ACTIVITIES ON STUDENTS' ACQUISITION OF PROCESS SKILLS IN BIOLOGY.

Please indicate you response by ticking [√] the appropriate or best option applicable to statement provided.

Rating scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD)

Statement	SA	A	N	D	SD
20. My practical skills have been developed through the use of hands-on activities in the biology lesson.					
21. My experimental skills have been developed through the use hands on practical activities in the biology lesson.					
22. Through hands-on activities I can now properly handle equipment and use tools and equipment for practical and experimental work ease.					
23. I can now do development of hypotheses, planning and designing of experiments, persistence in the execution of experimental activities, modification of experimental activities where necessary, in order to reach conclusion are things.					
24. I can draw a well labelled diagram, make graphical representations boldly and clearly pertinent to the issue at hand.					
25. I am able to present pertinent and precise reports on projects I undertake. Reports, oral or written, be concise, clear and accurate.					
26. I am able to; observe safety measures in the laboratory, care and have concern for the safety of myself and for others, work alone and with others, be economical with the use of materials, ensure clean and orderly work area, persist in achieving results, ensure creative use of materials.					
27. I am able to: evaluate data in terms of its worth, good, bad, reliable, unreliable, etc., make inferences and predictions from written or graphical data, extrapolate, and derive conclusions.					
28. I am able to make accurate use of measuring instruments and equipment for measuring, reading and making observations.					

APPENDIX B

QUESTIONAIRE FOR TEACHERS

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

Dear Respondent,

I am undertaking a study on: "**Effect of hands-on activities on students' performances in the teaching of selected topics in biology''** in your school in the Upper West Region. The study is for academic purposes only. You was contributing to its success if you answer the items as frankly and honestly as possible. Your responses was kept confidentially. Kindly read through each of the items carefully and indicate the option that is the nearest expression of your opinion on the issues raised.

Thank you for your cooperation and assistance.

GENDER: [Male ( ) Female ( ) {Please Tick √}

General Instruction

Please indicate you response by ticking [√] the appropriate bracket or column and fill in the blank spaces provided where applicable.

SECTION A: BIODATA

29. Gender a**) Male** [ ] b) **Female** [ ]
30. Which subject do you teach in this school? a) **Biology** [ ] b) **Integrated Science** [ ]
31. How long have you taught the subject in the school a) 1-3yrs [ ] b) 4-6yrs [ ] c) 7-10yrs d) 11 and above
32. What is the entry behaviour of your science students? Most of them are admitted with grades between; a) 6-10 [ ] b) 11-20 [ ] c) 21-30 [ ] d) 31-40 [ ]
33. What is the average size of the biology class you teach ………………………..

BIOLOGY TEACHERS' PERCEPTION OF HANDS-ON ACTIVITIES.

Please indicate your response by ticking [√] the appropriate or best option applicable to statement provided.

Rating scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD)

Statement	**SA**	**A**	**N**	**D**	**SD**
1. Students cannot do well without engaging in Hands-on activities.					
2. Hands-on activities are very essential for sustainable academic growth of students.					
3. Hands-on activities enhance students' intellectual ability.					
4. Through Hands-on lessons, students learn to behave and work like scientists.					
5. Through Hands-on activities, students learn to appreciate the role of science and scientists.					
6. Hands-on activity gives training in problem - solving, thus promoting self-reliance.					
7. Training in laboratory using helps students to develop skills necessary for more advanced study and research.					
8. Hands-on activities promote better understanding and interest in biological concepts.					
9. Hands-on activities provide training in acquisition of science process skills.					
10. Hands-on activities do not have much effect on students' performances in Biology.					
11. Students still perform well in exams even when they are not taught using hands-on activity method.					
12. Students can still learn science process skills without engaging in hands-on work.					
13. Hands-on work is not very important in Biology.					

CHALLENGES BIOLOGY TEACHERS FACE IN ORGANISING HANDS-ON ACTIVITIES.

Kindly outline some of the challenges you encounter/face in your effort to use/incorporate hands-on activities in your biology lesson:

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APPENDIX C

STUDENTS' ACHIEVEMENT TEST ON SELECTED TOPICS

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

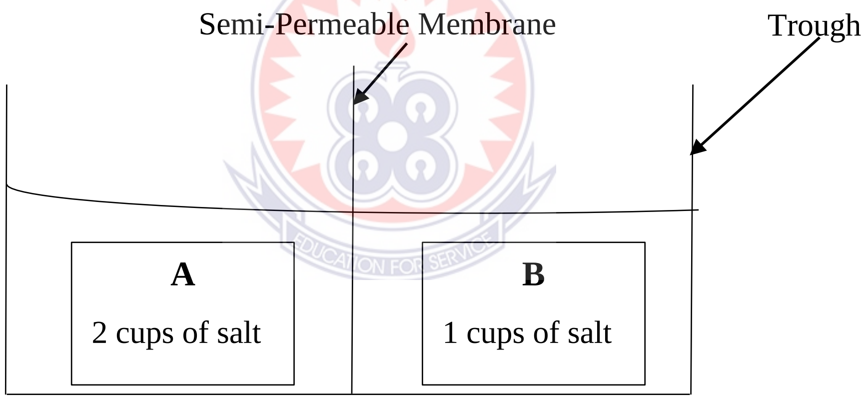
Please read the following sentences and kindly provide the information required.

GENDER: [Male ( ) Female ( ) {Please Tick √}

General Instruction: *Please indicate your response by circling the appropriate option or by filling the blank spaces provided where applicable.*

SECTION A: Movement of substances (Osmosis)

Consider the diagram below made up of two different solutions separated by a partially permeable membrane represented with dotted line and use it answer the following questions.



1. i) Which solution has more solute relative to the solvent?

   ……………………………………………………………………………………..

   ii) Give reason for your answer.

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2. i) Which solute has more water/solvent relative to the solute?

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   ii) Kindly provide a reason for your answer

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3. i) Which solution is more dilute?

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   ii) Give reason for your answer

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4. i) Which solution does water molecules move freely?

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5. i) Which solution has higher water potential?

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   ii) Give reason for your choice of answer in Question (**5) (i)**

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6. i) Which solution has higher osmotic pressure?

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   ii) Give reason for your answer

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7. i) Will diffusion of salt occur between the two solutions? Yes ( ) No ( )

   ii) Give a reason for your choice in (7) (i) above

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8. What is the direction of net movement of water molecules?

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   Use the answer you have given in Question 8 above to define osmosis.

9. Movement of solvent molecules from a ……………….. solution to a ……………… solution across a permeable membrane.

10. In term of solvent concentration, osmosis id defined as the movement of ………….. molecules from a region of their …………………. Concentration to a region of …………………. Concentration across a partially permeable membrane.

11. What is the difference in the level of solution **A** and **B** when Osmosis is observed

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12. When will the change remain constant?

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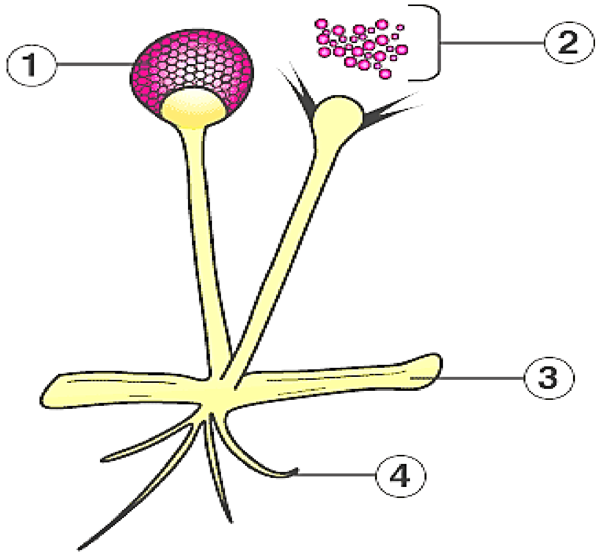
SECTION B: Preparation of Temporary Slide/Wet Mount and Life Processes of Organism (*Rhizopus*)

13. Study the diagram below carefully and answer the questions that follow.



i) What Organism is represented above? ....

ii) Which phylum is the organism classified? ....

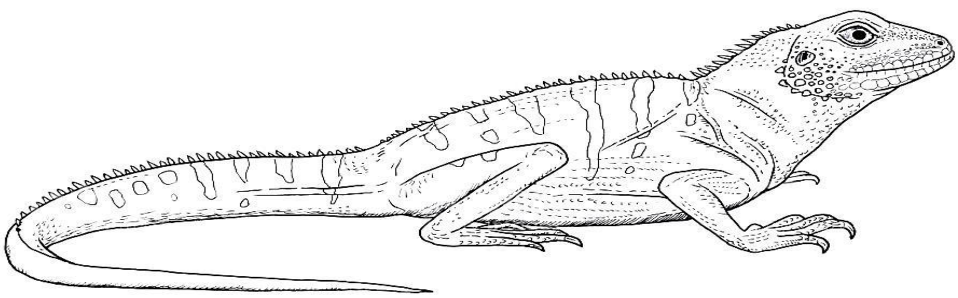
iii) What features will you consider in classifying the above organism into its phylum?

iv) What name is given to the parts label the numbered **1, 2, 3, & 4?**

v) What is the ecological value of the organism to the environment?

SECTION C: Life Processes of Organisms (Agama Lizard)

14. What are the functions of scales in Agama lizard below? Outline any **three**



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15. Outline any four observable features that are adaptations to sexual behaviour in Agama lizard.

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16. What **three** features of the Agama lizard qualifies it to be classified into the order reptilia/reptiles

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APPENDIX D

INTRODUCTORY LETTER

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF SCIENCE EDUCATION
DEPARTMENT OF INTERGRATED SCIENCE EDUCATION
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+233 (020) 2041077

Our ref. No.: ISED/PG.1/Vol.1/19
Your ref. No.:

11th October, 2021

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION
MR KPEMUONYE, ALBAN KANINGEN NUBAZUNG

We write to introduce, Mr Kpemuonye is a postgraduate student of the Department of Integrated Science Education, University of Education, Winneba, who is conducting a research titled:

Effect of hands on activities on students' performance in selected topics in Biology

We would be very grateful if you could give the assistance required.

Thank you.

Yours faithfully,

ALEXANDRA N. DOWUONA
PRINCIPAL ADMIN. ASSISTANT
For : HEAD OF DEPARTMENT

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